

LEARNING FROM POST-PROJECT REVIEWS: A CROSS-CASE ANALYSIS

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ABSTRACT

Every new product development (NPD) project should not only deliver a successful new product but also generate learning for the organization. Post-project reviews (PPRs) are recognized by both practitioners and academics as an appropriate mechanism to stimulate and capture learning in NPD teams. However, relatively few companies use PPRs, and those that do utilize them often fail to do so effectively. Although they are widely perceived to be a useful tool, empirical research on how PPRs are typically organized and the learning that results is limited.

This article addresses this gap in the extant knowledge and describes five in-depth case studies, which were conducted at leading companies in Germany. A detailed investigation was made of how PPRs are conducted, and the type of learning that can result. Three main sources of data were used for each case: company documentation; in-depth interviews with managers responsible for NPD; and observation of an actual PPR. The different data sources enabled extensive triangulation of data to be conducted and a high degree of reliability and validity to be achieved.

The analysis enabled a number of key characteristics of the way PPRs are managed to be identified. Various characteristics of PPRs influence their utility, such as the time at which they take place and the way discussions are moderated. In addition, the data show that participants in the discussions at PPRs often use metaphors and stories, which indicates that PPRs have the potential to generate tacit knowledge. Interestingly, the data also showed that there are various different ways in which metaphors and stories appear to stimulate discussions on NPD projects.

Based on the cross-case analysis, a wide range of implications are identified. Researchers need to investigate PPRs further to identify how they can generate tacit and explicit knowledge and support project-to-project learning. Especially the topic of tacit knowledge generation in a NPD context needs further investigation. The research also led to a range of recommendations for practitioners. Companies need to strongly communicate the purpose and value of PPRs, run them effectively to stimulate the maximum possible learning, and disseminate the findings widely. PPRs have the potential to create and transfer knowledge amongst NPD professionals but, as they are seldom currently used, many companies are missing an important opportunity.

BIOGRAPHIES

Ursula Koners has experience in R&D management at DaimlerChrysler and is currently a project manager for a German publisher. During the last five years she studied part-time for a PhD in management at Cranfield and successfully defended her thesis in January 2006. Her research on post-project reviews has been successfully presented at a number of conferences and she has published one previous paper, in *Creativity and Innovation Management*.

Keith Goffin is professor of innovation and new product development at Cranfield School of Management, UK. Prior to joining Cranfield, he worked for fourteen years in marketing and new product development for Hewlett-Packard. His research interests are in new methods of market research, supplier management, and knowledge management in R&D. He has published extensively and his latest book, *Innovation Management: Strategy and Implementation Using the Pentathlon Framework* was published by Palgrave in 2005.

INTRODUCTION

A valuable way to capture knowledge generated during the course of a new product development (NPD) project is to hold a post-project review (PPR). This 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). PPRs are also called ‘post-mortems’ (Collier, et al, 1996), and they can help companies prevent similar mistakes being made to those in previous NPD projects (Tidd et al, 1997). Although the importance of PPRs is frequently stressed by practitioners and academics alike, organizations responsible for NPD rarely conduct PPRs—as shown by a wide body of anecdotal evidence and a few empirical studies (e.g. Bowen et al, 1994; Huber, 1996; Saban et al, 2000). Rigorous research into how PPRs are typically conducted, or the learning that can occur, is scarce.

The range of the literature that is relevant to the study of PPRs is wide; both the NPD and project management literature give useful pointers. In addition, organizational learning theory is pertinent but, surprisingly, most researchers working in the NPD context have failed to apply the knowledge from this literature. This article starts by reviewing all three areas to identify gaps and gain insights into suitable methodologies for studying PPRs. Next, it explains the logic for choosing case study methodology and the actions taken to ensure validity and reliability. The results from the five exploratory cases are then presented. Finally, conclusions are drawn and implications are identified for NPD practitioners and academics alike.

REVIEW OF THE EXTANT LITERATURE

NPD Literature

Knowledge has become recognized as a major source of long-term competitive advantage in research and development—R&D (Corso et al, 2001). It should be noted that R&D departments conduct both basic research projects (e.g. investigating new technology) and product development. PPRs can be conducted at the end of either type of project but this article focuses on NPD. The importance of learning from NPD projects has been emphasized by several authors (e.g. Leonard-Barton, 1992; Liyanage et al, 1991). A number of researchers have recognized that very few companies use PPRs (Bourgault and Sicotte, 1998; Bowen et al, 1994; Wheelwright

and Clark, 1992) but only two have demonstrated this empirically. One study showed that two out of 33 microelectronic manufacturers used formal PPRs (Boag and Rinholm, 1998). Goffin and Pfeiffer (1999) found that only four of their 16 case study companies conducted PPRs but failed to give details on how they were used.

The weak empirical basis of our knowledge of PPRs in the NPD context is demonstrated by Table 1, which shows the main studies listed in chronological order. It can be seen that these studies are either based on single case studies or rely on single data sources (e.g. interviews). There have been a number of articles in the literature which focus on software projects (e.g. Abel-Hamid, 1990) and one of these is included in Table 1 (Pitman, 1991). Unfortunately, the articles on software all make recommendations based solely on the authors' opinions without providing any empirical evidence.

All of the studies in Table 1 include observations and recommendations on how PPRs should be conducted. These are placed in 14 categories connected with organizing PPRs and disseminating the results. For example, four articles (Pitman, 1991; Wheelwright and Clark, 1992; Lilly and Porter, 2003; Von Zedtwitz, 2003) stress the need for clear objectives to be set for PPRs. Interestingly, only Sinofsky and Thomke (1996) make a recommendation on the appropriate duration for a PPR. Reviewing the findings of the previous studies shows that several of them identify only a few points (e.g. Ayas, 1996) whereas others make up to eight recommendations (Sinofsky and Thomke, 1996; Von Zedtwitz, 2003). No single article has identified all of the categories. The later studies (Lilly and Porter, 2003; Von Zedtwitz, 2003) do identify more points than some of the earlier studies but Table 1 demonstrates that these researchers have not taken sufficient account of prior research because they have overlooked several points, such as the duration of PPRs and the discussion method.

Most researchers have ignored learning theory when looking at knowledge creation in NPD (McKee, 1992) and this is the case for the studies in Table 1. All of them focus on knowledge that can be documented and easily shared and fail to recognize that there is more to learning than that which is documented in written reports. This point will be discussed further after a review of the project management literature.

	Study	Pitman (1991)	Wheelwright & Clark (1992)	Ayas (1997)	Duarte & Snyder (1997)	Sinofsky & Thomke (1999)	Lilly & Porter (2003)	Von Zedtwitz (2003)
	Empirical basis	Personal experience of author of software projects	Various case studies	Case study from aircraft manufacturing industry	Single case study at Whirlpool Corporation	Examples from Microsoft and other software developers	Two stage research in various organizations	Convenience sample of 63 R&D managers plus interviews at 13 companies
	Methodology used	• No details given	• No details given	• “Action research” • No further details given	• Action research • Claims to use a model from organizational learning – but it is unclear how	• No details given	• Exploratory interviews with 16 NPD managers in 8 organizations. • Mail survey across 49 companies • Focus on explicit knowledge	• Survey questionnaire • Qualitative feedback from interviewees
1	Objective of PPRs	√	√				√	√
2	Timing of PPRs					√		√
3	Duration of PPRs					√		
4	PPR participants		√			√	√	√
5	Moderation of PPRs				√			√
6	PPR discussion method	√		√				
7	Location for PPR					√		√
8	Use of guidelines for PPRs	√						
9	Preparation of PPRs					√	√	√
10	Atmosphere during PPRs				√			√
11	Results of PPRs	√				√		√
12	Dissemination of PPR results		√			√	√	
13	Creation of action points			√		√		
14	Agreement on improvement suggestions			√	√			

Table 1: PPR Studies from the NPD Literature

Project Management Literature

The need to review project activities in a formal and structured manner became apparent at the end of the 1950s—parallel to the emergence of the project management discipline itself (Weinberg and Freedman, 1984). Later, recommendations started to appear on how to conduct PPRs (e.g. Gulliver, 1987). Surprisingly, considering their advantages, the adoption of PPRs has been slow and it is interesting to note that it was only the 2000 edition of the well-known *Project Management Body of Knowledge* that first gave advice on how reviews should be carried out (Project Management Institute, 2000)

Table 2 gives an overview of the five main publications in the project management literature, using the same categories as in Table 1. It can be seen that fewer points have been identified in the project management literature and for example, there are no observations on the appropriate timing and duration of PPRs. Unfortunately, the recommendations in several articles are quite vague and difficult to apply (e.g. “encourage deep analysis” or “discourage glib categorization” are not explained in Busby’s 1999 article). The validity of the project management research is also questionable because how data were collected and exactly how the conclusions were reached is unclear in most of the articles. For example, although Schindler and Eppler (2003) claim to have conducted action research in nine companies, their article does not indicate that the accepted approaches for action research were followed. The article gives no indication of the similarities and differences in the views of the 46 respondents interviewed. In addition, as no PPRs were observed, the manager-reported data were not triangulated. Collating the methodologies of previous studies (e.g. combining Busby’s idea of observing PPRs with Schindler and Eppler’s in-depth interviewing) appears a potentially more valid way to investigate PPRs.

	Study	Freedman & Weinberg (1977)	Baird et al (1999)	Busby (1999)	Right Track Associates (2000)	Schindler & Eppler (2003)
	Empirical basis	Personal experiences of authors	Anecdotal examples from US Army projects	4 PPRs in 3 different capital equipment organizations	Practical consulting experience	Action research in nine multinational companies
	Methodology used	<ul style="list-style-type: none"> No details provided 	<ul style="list-style-type: none"> No details given, only discusses how the guidelines could be used by companies 	<ul style="list-style-type: none"> PPRs were observed and discourse analysis was performed It is unclear whether the study was systematically conducted No clear link between the findings and the recommendations 	<ul style="list-style-type: none"> No details given 	<ul style="list-style-type: none"> 46 Semi-structured expert interviews Half-day follow-up workshops Gives almost no details of the methodology Apparently no use of the recognised approaches to action research
1	Objective of PPRs					
2	Timing of PPRs					
3	Duration of PPRs					
4	PPR participants	√		√		
5	Moderation of PPRs					√
6	PPR discussion method	√		√		√
7	Location for PPRs					
8	Use of guidelines for PPRs					
9	Preparation of PPRs	√				√
10	Atmosphere during PPRs	√	√			
11	Results of PPRs	√			√	√
12	Dissemination of PPR results	√		√		√
13	Creation of action points					√
14	Agreement on improvement suggestions					

Table 2: PPR Studies from the Project Management Literature

Organizational Learning

In the investigation of PPRs, both the NPD and project management literatures focus on knowledge that can be easily shared and documented. This is a limitation as there can be more to learning than what is documented in project reports. Here, the organizational learning literature can provide insights, as it focuses on the concept of “knowledge”, which has been heavily influenced by the work of Nonaka (1994). His ideas relate back to Polanyi (1962) and his famous quote that “we can know more than we can tell”. This indicates that there are two types of knowledge: “explicit” and “tacit”. Explicit knowledge is what we can readily explain and document, whereas tacit knowledge is difficult to articulate and exists at a subconscious level. Nonaka identified that social interactions are essential for knowledge transfer and the transfer of tacit knowledge is an essential component of learning complex tasks (Nonaka, 1996).

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 – and in particular tacit knowledge - can only be produced and held collectively (Howells, 1996).

It should be noted that there is some controversy on tacit knowledge and whether it can be converted into explicit knowledge has been disputed (Cook and Brown, 1999). 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. Therefore, the main problem with attempting to apply the concepts from the organizational learning literature to NPD is the difficulty to operationalize tacit knowledge. By definition, tacit knowledge cannot be clearly expressed, documented, or observed and so it is necessary to use special data collection and analysis techniques. 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).

Metaphors and stories appear to be a useful starting point to understand the exchange of tacit knowledge; however, specific studies of metaphors and stories are rare. Another approach from psychology—repertory grid technique, which will be discussed later—appears to access tacit knowledge (Goffin, 2002; Reed, 2000). However, studying tacit knowledge empirically is a problem area (Wong and Radcliffe, 2000).

Conclusions on the Literature

The review of the different areas of literature relevant to PPRs showed:

- A number of characteristics of PPRs have been identified but no previous study has consolidated our understanding;
- There is a need for systematic investigation, using multiple data sources to determine how PPRs are actually conducted and to identify what influences their utility;
- Knowledge has both explicit and tacit dimensions, which need to be considered.

RESEARCH DESIGN

The gaps identified in the literature and the insights gained from organizational learning theory led to a detailed study of PPRs. This addressed a number of research questions, two of which are considered in this article:

- How do R&D organizations conduct post-project reviews?
- Do PPRs promote the creation and transfer of tacit knowledge?

Choice of Case Study Methodology

As there has been limited previous research, this study was exploratory in nature and in-depth case studies were selected for three main reasons. Firstly, case studies are appropriate when conducting exploratory research on complex social phenomena in real-life contexts (Eisenhard, 1989; Yin, 1994). Secondly, they allow researchers to observe formal as well as informal processes (e.g. social interactions) within an organization and collect a wide array of data (Hartley, 1994). Thirdly, R&D managers have been found to be positively inclined to case study research (Gassmann, 1999). However, in choosing case study methodology, the researchers recognized that the study needed to be carefully designed to ensure sufficient rigour.

Data Sources

The most important issues in achieving high-quality case study design are construct validity and internal validity (Easton, 1995; Miles and Huberman, 1994). Construct validity is related to choosing appropriate constructs for the topic and establishing suitable operational measures for the concepts being studied (Mason and Bramble, 1989). This was largely achieved by using a technique—repertory grid—in which interviewees both identify and explain the key constructs themselves. A semi-structured questionnaire was also used for the interviews and this was based on the work of previous researchers and included questions probing each of the 14 key characteristics of PPRs (as shown in Tables 1 and 2).

Internal validity refers to the reliability of a study (Dane, 1990) and, in order to maximize internal validity, multiple sources of data were used. This is in contrast to previous studies, most of which did not take the opportunity to triangulate data. Figure 1 gives an overview of the three data sources:

- *Company Documents.* Copies of company confidential documents on both the process of conducting PPRs and minutes from specific PPRs were obtained and a content analysis was conducted. Documents were coded according to categories identified from the literature. Secondly, documents were coded for any “lessons learned” mentioned. Obviously, lessons learned that are documented reflect explicit knowledge and so documents were also checked to see if they recorded the use of metaphors and stories;

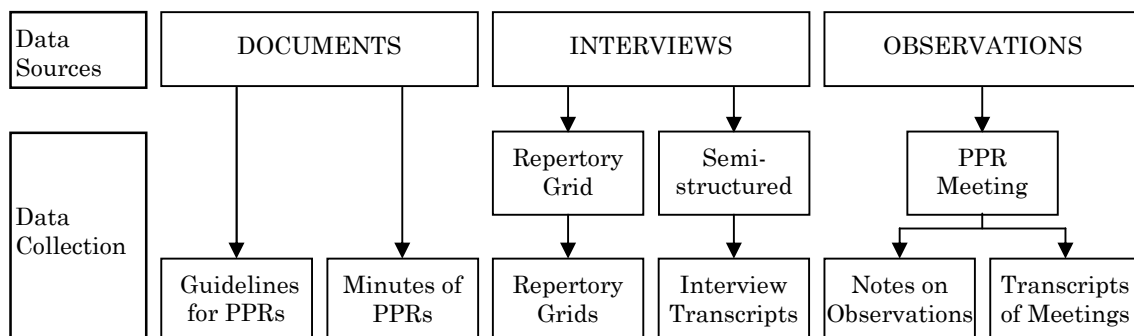


Figure 1: Multi-Faceted Design of Case Studies

- *Interviews.* At each company six interviews were conducted with R&D managers or project participants who were actively involved in NPD. Interviewees were chosen in conjunction with the case companies, to include a range of levels of experience. Each interview was firstly based on repertory grid technique. This technique is especially useful in exploratory research settings where interviewees find it hard to articulate their views or where bias is an issue (Goffin, 2002). Respondents were asked to name six projects in which they had participated in the past (the *elements* of the repertory grid technique) and these were written on numbered cards. Groups of three cards, selected randomly, were presented to the interviewee with the question: “*Looking at the three projects written on the cards – how are two of these projects similar and different to the third in terms of what you would do differently if you were doing the projects again.*” Answers to this question elicited what are called *constructs* in repertory grid terminology. These are the key attributes of the subject under investigation – in this study “lessons learned” from completed projects (our findings on the typical types of lessons learnt have been reported elsewhere: Koners and Goffin, 2005). The particular advantage of repertory grid technique is that it forces the respondent to think deeply and probes their tacit knowledge. In addition, semi-structured questions on PPR practices were asked (based on the topics in the literature). Typical questions included “*when are PPRs normally conducted at your company?*” (probing for the *timing* of PPRs) and “*who typically takes part in PPRs?*” (to identify the typical *participants*). Both the repertory grid and semi-structured section of the interviews were piloted.
- *PPR Observation.* A PPR was observed (and recorded) at four from the five companies and these were analyzed for metaphors and stories using Nonaka’s recommendations. Also attention was paid to the interaction of PPR participants as a potential evidence for tacit knowledge creation and transfer.

The collection of data per case typically required 5 non-consecutive days of on-site visits. The participating companies were promised feedback on their PPR processes and this was completed through either a written report with recommendations (in one case) or an additional on-site visit and presentation by the researchers (four cases).

Sample

The sampling frame chosen was the 50 largest companies in south Germany. This is considered to be Europe's leading high-tech region because of its high level of R&D investment and the highest number of patents generated (Staatsministerium Baden-Württemberg, 2001). Companies were contacted in writing and from the minority that were found to conduct PPRs, five companies from different industries agreed to the study. Companies from different sectors were chosen to avoid having direct competitors in the final sample (an important aspect in establishing trust and gaining co-operation). The five companies will, for reasons of confidentiality, be designated EngineeringCo, AppliancesCo, MedCareCo, MachineryCo and PublishingCo, (the pseudonyms indicate the sector in which they are active). Table 3 gives an overview of the sample companies and the data collected at each site. Data collection was conducted by a native German backed by a non-native fluent German speaker. EngineeringCo was used as a pilot, during which the analysis frameworks were generated and verified. In later cases, due to the experience with the pilot, data collection was more focused and a number of questions were omitted from interviews. This means that the available data and the analysis used were consistent across the five cases.

Companies	Turnover	Employees (approx)	PPR Guidelines (NPD process documentation)	Minutes of Specific PPRs Inspected?	R&D Interviews Conducted?	Observation of a PPR?
EngineeringCo	> 1 Billion Euro	5.000	Yes	Yes, 4 sets (copies made)	Yes - 6	Yes
AppliancesCo	1,5 Billion Euro	7.000	Yes	Yes, 3 sets (copies made)	Yes - 6	Yes
MedcareCo	1,3 Billion Euro	10.000	Yes	Yes, 3 sets (on-site inspection)	Yes - 6	Yes
MachineryCo	400 Million Euro	3.000	Yes	Yes, 4 sets (on-site inspection)	Yes - 6	Yes
PublishingCo	300 Million Euro	2.000	Yes	Yes, 5 sets (copies made)	Yes - 6	No (company refused access)
				Total = 19	Total = 30	

Table 3: Overview of Sample and Data Availability

Data Analysis

Case analysis was conducted in three main stages, following the recommendations of Miles and Huberman (1994):

- *Within case analysis.* Data from each case were analyzed separately to give a complete picture of the company's approach to PPRs. The same data analysis framework was used for each case. For example, to understand PPR practices, evidence from the different interviews was collated and then triangulated with both

evidence from the documentation and the observation of a PPR. (Copies of the coding and analysis frameworks are available from the authors.)

- *Data reduction.* This was performed and 2-3 page case descriptions were written on each company. The descriptions were then submitted to informants at the case companies to check that they did not contain information that was likely to compromise their NPD plans. Secondly, informants checked the detail given in the case description—and a number of small corrections were made. Such feedback from informants is essential to prevent observer bias (Lincoln and Guba, 1985) and in establishing the credibility of an interpretation (Wallendorf and Belk, 1989).
- *Cross-case analysis.* Comparisons across the five companies were made, to determine where similarities and differences existed and to identify a number of “best practices” (Yin, 1994).

RESULTS: CROSS-CASE ANALYSIS

Characteristics of PPRs

Table 4 summarizes how PPRs are organized at the case companies. The data collected allowed a comprehensive picture of how PPRs are conducted to emerge. The 14 categories identified from the literature were used as the framework for both data analysis and presentation and, within each of the categories, the data sources used are indicated. For example, to get a detailed and valid understanding of the *objectives* of PPRs, data from guidelines, minutes of specific PPRs, interview transcripts and the observations of PPRs were triangulated. Several of the categories shown in Table 4 will be discussed, in order to demonstrate how the conclusions were reached.

	Characteristics of PPRs – 14 Categories	Data Sources Used per Category	EngineeringCo	AppliancesCo	MedCareCo	MachineryCo	PublishingCo	Conclusions
1.	Objective of PPRs	PPR guidelines Minutes of specific PPRs Interview transcripts Observation	<ul style="list-style-type: none"> To analyze experiences. To learn from mistakes and to apply this to future projects. 	<ul style="list-style-type: none"> Official end of project. To learn from mistakes and problems and thus avoiding the repetition of mistakes. 	<ul style="list-style-type: none"> Official end of project Release of project manager from his responsibilities. To learn and find improvement suggestions. 	<ul style="list-style-type: none"> Analysis of project outcome and the gained experiences. Find improvement suggestions for future projects. 	<ul style="list-style-type: none"> Improvement of development and strategy process. Learning from mistakes and avoiding them in future projects. 	<ul style="list-style-type: none"> 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	PPR guidelines Minutes of specific PPRs Interview transcripts Observation	<ul style="list-style-type: none"> Guideline is approximately 6 months after market launch . Typically 12 months after launch. 	<ul style="list-style-type: none"> Guideline is directly after market launch. In practice at least 6 months after market launch. 	<ul style="list-style-type: none"> Guideline is 6 months after market launch. In practice sometimes earlier because of time pressure or senior management priorities 	<ul style="list-style-type: none"> Guideline is 6 months after market introduction. In practice often later because of lack of availability of the necessary participants. 	<ul style="list-style-type: none"> Business reviews are done in March for a whole range of different projects which were launched the year before. In practice often later than March. 	<ul style="list-style-type: none"> 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	PPR guidelines Minutes of specific PPRs Interview transcripts Observation	<ul style="list-style-type: none"> Max. three hours 	<ul style="list-style-type: none"> Full day 	<ul style="list-style-type: none"> Max. two hours 	<ul style="list-style-type: none"> One hour 	<ul style="list-style-type: none"> Full day for business review of several projects, two hours for regular PPRs. 	<ul style="list-style-type: none"> Length of PPRs varies a lot which is also reflected in the results and depth of discussion
4.	PPR Participants	PPR guidelines Minutes of specific PPRs Interview transcripts Observation	<ul style="list-style-type: none"> Core project team 	<ul style="list-style-type: none"> Project team with moderator from outside the project. Final presentation is made to senior management 	<ul style="list-style-type: none"> Full project team. For strategic projects the steering committee is also present. 	<ul style="list-style-type: none"> Core project team 	<ul style="list-style-type: none"> Management board for business reviews Project team for regular PPRs 	<ul style="list-style-type: none"> 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	PPR guidelines Minutes of specific PPRs Interview transcripts	<ul style="list-style-type: none"> Project manager 	<ul style="list-style-type: none"> Moderator from internal training unit 	<ul style="list-style-type: none"> In some cases an internal auditor 	<ul style="list-style-type: none"> Project manager 	<ul style="list-style-type: none"> Project manager For business review it is the NPD director 	<ul style="list-style-type: none"> The responsibility for running and moderating a PPR is often given to the

		Observation						<ul style="list-style-type: none"> 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	Interview transcripts Observation	<ul style="list-style-type: none"> Discussion of causes and consequences after a first feedback round of the present team 	<ul style="list-style-type: none"> Personal satisfaction curves, causal mapping and many opportunities for story telling and metaphors during the day. Visual aids frequently used. 	<ul style="list-style-type: none"> Unstructured discussion without using special tools. 	<ul style="list-style-type: none"> Rich discussion of personal experiences with the team based on questions from project manager Facilitated by social setting in a restaurant 	<ul style="list-style-type: none"> Structured discussion following guideline for business reviews, unstructured without tools for regular PPRs. 	<ul style="list-style-type: none"> Generally, the setting , The questions from the moderator and the visual aids used appear to influence the depth of discussion and the learning generated.
7.	Location for PPR	PPR guidelines Interview transcripts Observation	<ul style="list-style-type: none"> Meeting room 	<ul style="list-style-type: none"> External training center 	<ul style="list-style-type: none"> Meeting room 	<ul style="list-style-type: none"> Meeting room or social setting (e.g. room in a restaurant) 	<ul style="list-style-type: none"> Normal meeting room 	<ul style="list-style-type: none"> 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	PPR guidelines Interview transcripts Observation	<ul style="list-style-type: none"> Not widely used, only as final check of project manager before PPR takes place. 	<ul style="list-style-type: none"> Existence of company guidelines is not widely known and thus is not used. 	<ul style="list-style-type: none"> Overall handbook with checklists is used – also for PPRs. 	<ul style="list-style-type: none"> Only official formsheets from guideline are used as they are compulsory. 	<ul style="list-style-type: none"> Guidelines for PPRs do not exist. 	<ul style="list-style-type: none"> 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	PPR guidelines Minutes of PPRs Interview transcripts Observation	<ul style="list-style-type: none"> Team reflection in advance on basis of project archive and advice from experienced colleagues. 	<ul style="list-style-type: none"> Team prepares positive and negative aspects, project manager prepares details with moderator. 	<ul style="list-style-type: none"> Project manager based on checklists and team reflection. 	<ul style="list-style-type: none"> Team prepares positive and negative aspects, project manager prepares agenda. 	<ul style="list-style-type: none"> Team reflection, for business reviews each project manager provides written feedback. 	<ul style="list-style-type: none"> 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	Minutes of PPRs	<ul style="list-style-type: none"> Open, constructive and 	<ul style="list-style-type: none"> Very open and 	<ul style="list-style-type: none"> Formal and 	<ul style="list-style-type: none"> Informal, open and 	<ul style="list-style-type: none"> Business reviews very 	<ul style="list-style-type: none"> Degree of openness and

	PPRs	Interview transcripts Observation	focused of facts	informal	professional	social	formal, regular PPRs informal and open.	formality depends on participants and company culture “atmosphere” • Hard to measure but very important.
11.	Documentation of the results of PPRs	PPR guidelines Minutes of PPRs Interview transcripts Observation	<ul style="list-style-type: none"> Only limited documentation of results from the PPR, as the focus is on the discussion itself and not on documenting the outcome. 	<ul style="list-style-type: none"> PPR minutes with recommendations. Presentation to the board at end of PPR. 	<ul style="list-style-type: none"> Final project report, PPR minutes as well An action plan to follow up. 	<ul style="list-style-type: none"> Final report to steering committee with three lessons learned apart from quantitative data. 	<ul style="list-style-type: none"> Action minutes with allocated responsibilities. 	<ul style="list-style-type: none"> 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	Minutes of PPRs Interview transcripts Observation	<ul style="list-style-type: none"> Information stays within the project team although general topics were discussed. Learning is seldom ever followed up. 	<ul style="list-style-type: none"> Report sent to top management. Also distribution across business units. 	<ul style="list-style-type: none"> Very limited outside of the project team, mainly dissemination to the steering committee. 	<ul style="list-style-type: none"> Project team and steering committee. Follow up of action points done by project manager. 	<ul style="list-style-type: none"> Minutes to project team and if general issues are included also to management. Results from business reviews not disseminated at all. 	<ul style="list-style-type: none"> 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	PPR guidelines Minutes of PPRs Interview transcripts Observation	<ul style="list-style-type: none"> Agreed during the discussion and documented by the project manager to include them in minutes. 	<ul style="list-style-type: none"> Derived during the PPR and documented for team and senior management. Responsibility not always clear. 	<ul style="list-style-type: none"> Derived during the discussion and fixed in minutes with responsible person and deadline. Project manager responsible for follow up. 	<ul style="list-style-type: none"> Open action list is part of official final project report, thus documented with responsible person and deadline. 	<ul style="list-style-type: none"> Included in action minutes, for regular PPRs, for business review nothing done. 	<ul style="list-style-type: none"> Action points are derived by all companies. Follow-up is problematic if responsibility is not allocated to project manager.
14.	Agreement on improvement suggestions	PPR guidelines Minutes of PPRs Interview transcripts Observation	<ul style="list-style-type: none"> Discussed and documented in minutes. 	<ul style="list-style-type: none"> Team derives at least five improvement suggestions, documents them in minutes and presents them to senior management. 	<ul style="list-style-type: none"> Discussed, but not always documented in minutes or included in handbooks or guidelines. 	<ul style="list-style-type: none"> Team needs to derive at least three recommendations in the official report. Usually more than three are derived and documented. 	<ul style="list-style-type: none"> Derived and discussed on the basis of bad experiences. Process improvements are most likely to be documented. 	<ul style="list-style-type: none"> 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 4: Characteristics of PPRs across the Case Studies

The objective of a PPR is generally the identification of the lessons that can be learned from the project. However, in interviews it also emerged that PPRs were perceived by participants to be an important part of project “closure”; where the responsibility moves from R&D to other departments, notably manufacturing and marketing. Interestingly, none of the companies’ official processes recognized the importance of PPRs for dissemination of knowledge. Making this an objective could make PPRs more effective.

PPRs are usually scheduled 6 months after the market introduction, in order to include learning about how the product has been received by customers. However, in practice PPRs take place later because of difficulties to find a date for all participants. At EngineeringCo, the process guidelines suggest 6 months after the project is finished. This view was confirmed by Interviewee 6 (and others) at EngineeringCo: *“It should not be directly after the product release, but later. The aim is after about 6 months”*. However, checking the minutes of specific PPRs showed that four reviews at EngineeringCo took place an average of 10 months after product introduction.

Three of the companies have PPRs that take between one and three hours and one company invests a full day. At four of the case companies, PPRs are attended only by the project team. In contrast at AppliancesCo the interest of senior management has a big influence on the time and effort invested in PPRs. At this company, the Chief Technology Officer personally introduced the PPR process, and a full day is invested, off-site and an internal company trainer is utilized as a moderator. The results at the end of the PPR day are presented to the CTO and other senior managers.

Although PPR guidelines existed in all case companies, generally, project managers prefer to prepare and organize the PPR in cooperation with their team members, or with the help of experienced colleagues. The objective of a typical PPR is an objective analysis of the project phases and outcome as well as a gathering of lessons learned.

Across all five cases it is interesting to note that it is mainly problems and negative aspects of NPD that are discussed. *“Most of the time is focused on what was good and what was bad. But it is usually very quickly into the direction what was bad because the good things you take for granted and... The focus is always on the negative things.”* (Interviewee 5, EngineeringCo). A similar statement was given by Interviewee 1 from AppliancesCo: *“We look more at the negative things, because*

patting ourselves on the back does not really help us to improve. And you can improve either by doing good things even better, but mainly by improving the problem areas.” The focus on discussing problems implies that PPRs mainly generate warnings of how to avoid certain problems. Recommendations based on successful practices are seldom mentioned and so the potential to share best practice is being missed.

All of the case companies produce minutes of specific PPRs and these included a list of at least three suggestions for improvement. However, the follow-up on these points is often weak and the dissemination of the knowledge gained from PPRs is limited. Common across all cases was that most project managers use PPRs as an opportunity to give their personal positive feedback to the project team. For example, managers of AppliancesCo and MachineryCo usually combine a PPR with an informal team dinner, whereas EngineeringCo and MedCareCo intend to introduce this in the near future.

Overall, Table 4 shows how our research provided comprehensive data on all of the characteristics of PPRs. Comparing the approaches of the different companies allowed a set of conclusions and recommendations to be made (right-hand column of Table 4), which will be discussed in a later section on implications for practitioners.

Explicit and Tacit Knowledge

Although the extant literature identifies the importance of PPRs, it does not specifically mention that they can generate both explicit and tacit knowledge. To investigate the second research question, the different data sources were checked for the use of metaphors and stories (as a proxy measure of tacit knowledge generation and exchange).

An example of the use of a metaphor was that used by the project manager at the PPR observed at MachineryCo. He said: *“you all know the many times I was begging on my hands and knees and the only thing we got was another punch in the stomach instead of plasters for our wounds”*. Here he was referring to the shortage of resources during a critical phase of the project and that there was no support from top management. However this only became clear to the observer after several minutes of the resulting discussion, where participants exchanged views on what they had learnt from this experience. Another example stems from the PPR at EngineeringCo, where a PPR participant used the phrase *“we are always at the very end of the food chain*

unfortunately” meaning that he was responsible for the final assembly of products and therefore vulnerable to suffering from all of the problems that were experienced during earlier project phases. Various examples of metaphors and stories were observed at AppliancesCo such as the use of the terms “*Reichsbedenkenträger*” (German metaphor for someone who has strong doubts about everything ‘Minister of Doubt’), and “*Made im Speck*” (German metaphor for someone who lives in pure luxury), or an experience which turned out to be a worse experience than “*Wurzelbehandlung*” (translation: having to endure root treatment at the dentist). From observing the PPRs it appeared that metaphors and stories acted as a catalyst for the discussion. However, the metaphors and stories may only be understood by the project team and would not be clear to anyone reading the minutes of the PPR (if the metaphors and stories were actually documented—something we will see is not the case).

An interesting aspect of metaphors and stories that emerged from the observations and analysis of the transcripts was the four ways in which they are linked to the discussion. Metaphors and stories often seem to start the discussion of a particular topic in an informal way, or act as a trigger for changing the subject. If metaphors and stories are used in the middle of a discussion, it was often to strengthen an argument, or to paraphrase an earlier argument, which might be easier for all participants to understand. Metaphors and stories were also used at the end of specific discussion points, as a form of summarizing the previous discussion. Finally, some were used in a ‘stand alone’ fashion, perhaps indicating that the metaphor or story was not powerful enough to stimulate discussion. Table 5 gives further examples of the four categories their frequencies; it can be seen that the most frequent usage was at the end of a discussion. (It should be noted that this analysis is a new approach that emerged from the data, as opposed to being recommended in the literature.)

Data source	Metaphor and related discussion	Place of metaphor	Total number of this type
PPR EngineeringCo.	<i>“We are on thin ice and still have quite a few problems.”</i> <i>Which consequences does all this have overall to our customers? Does thin ice mean we are able to deliver</i>	Metaphor at the beginning of the discussion	12

	<i>or do we need to postpone the market launch in most countries and are also forced to lower our sales expectations?...</i>		
PPR MedCareCo.	<i>... We have discussed this question very long internally. I have also talked with our CTO and asked him what is for him the definition of a project?</i> <i>“We are not able to find a rule that is 100% water proof.”</i> <i>This will never be possible. But what we did was with the colleagues from marketing and development we have developed indicators with which you can see if something is a task or a project. That helps at least to a certain degree and to avoid most of the confusion...</i>	Metaphor in the middle of the discussion	10
PPR AppliancesCo.	<i>...Everything apart from the project costs is in the green area, the costs are the only red point in the whole project.</i> <i>“Well then, we went through a red traffic light and get one point in Flensburg - and for 4 weeks no driving licence.”¹</i>	Metaphor at the end of the discussion	20
PPR AppliancesCo.	<i>“For the moment we only play here a bunch of Reichsbedenkenträger”</i> <i>(no direct translation possible, similar to “minister of doubt” meaning people who only have doubts, pessimistic thoughts and problems)</i>	Metaphor used alone	13
	<i>Total</i>		55

Table 5: Examples for the usage of metaphors and stories in the PPR discussions

Overall, 55 metaphors and stories were identified across the 15 hours of PPRs observed - on average one metaphor every 20 minutes. As the current research is the first time that the frequency of usage of metaphors and stories has been documented for PPRs, it is difficult to draw conclusions based on this frequency. No “benchmarks” were found in any of the relevant literatures.

Once the frequency of usage of metaphors and stories had been identified for the PPRs observed, the data from the repertory grid interviews and the minutes of PPRs were also coded and Table 6 shows the results. Interestingly, across the 19 documents of PPRs inspected, only four metaphors and stories were documented. This contrasts strongly with the use of 55 metaphors in the four PPRs observed. It

indicates that metaphors and stories are not generally documented by the project leaders who produce the minutes of PPRs. The repertory grid interviews are known to stimulate tacit knowledge and in the transcripts it was also found that metaphors and stories were used. The results indicate that much of the learning in PPRs is tacit in nature and is not documented in the minutes and as one interviewee said, *“During the discussion the real important points emerge within the team—you will never find these points in minutes or databases”*(Interviewee 7 - AppliancesCo).

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

Table 6: Number of metaphors and stories used during PPR discussions

Within the limitation of the exploratory current research, 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. They also appear to enable the transfer of knowledge on complex technological points by making the discussions understandable to those without detailed knowledge.

DISCUSSION AND RECOMMENDATIONS

Across the case studies PPR practices were systematically probed and the type of learning that results investigated. From the results it can be seen that many factors can influence the utility of PPRs. For example, if they are held too late there is a risk that key learning points will have been forgotten. Similarly, the way in which the discussions are moderated will influence the generation and sharing of knowledge. Any knowledge that the NPD generates should ideally be widely shared within the organization but this appears not to be happening sufficiently at the case companies.

The learning organization literature provides an understanding of how complex knowledge generation and exchange can be. Using metaphors and stories as a proxy measure, this study shows that the learning in PPRs is broader than what is documented in reports. This indicates that there is a deficit in our understanding of how NPD teams learn.

The current study's main limitations are linked to the sample of companies investigated, the way the cases were conducted, and the attempt to identify tacit knowledge generation and exchange. The five German companies studied cannot be taken to be representative of either German industry or manufacturing companies as a whole and so, here, wider survey research is needed. The case study protocol was designed to maximize internal validity through triangulation but it was still, to an extent, dependent on subjective interpretations of the researchers. With the experience gained from this study, construct validity could be improved still further. Tacit knowledge remains an elusive concept and our approach was simplistic and so this is an area where specific recommendations for further study can be made.

Recommendations for Researchers

There is an urgent need for more research on knowledge creation in NPD—it is somewhat ironic that knowledge is probably nowhere more important than in R&D but, in this context, it has hardly been investigated. The current study showed the need for research in five main areas:

1. A survey of PPR practices needs to be conducted using a representative sample of companies. It should identify both the frequency of usage of PPRs and their characteristics (using the 14 categories discussed in this article and a consideration of the role of tacit knowledge). Such research would allow generalizations to be made on how PPRs are used;
2. Systematic action research is needed to identify whether the recommendations from this study do lead to more effective PPRs and project-to-project learning. (Each of the five case companies received feedback and ideas from the researchers on how to improve their PPR processes. This was very well received and anecdotal evidence indicates that PPRs have been improved.);
3. The use of metaphors and stories has been recognized to be indicative of more innovative organizations and effective leaders (Buckler and Zien, 1996).

- However, their use in NPD teams has not been studied enough; ethnographic research could give powerful insights into how cross-functional NPD teams learn;
4. One of the most important points for academics remains the question of how the occurrence of tacit learning can best be captured and analyzed. As recommended by the organizational learning literature, the use of metaphors and stories was taken as a proxy measure for the creation and sharing of tacit knowledge. This led to the identification of different ways in which metaphors and stories are used in NPD discussions. However, more sophisticated approaches to understand tacit knowledge are needed;
 5. If PPRs are really effective, they will support project-to-project learning through disseminating best practice and by preventing similar mistakes being made to those in previous projects. Therefore, the way lessons learned are disseminated and help subsequent projects needs to be investigated. Such a complex topic would probably best be attempted through the use of longitudinal case studies.

Recommendations for Practitioners

An important question is: what can practitioners learn from this study of PPRs? In answer, eight main recommendations can be made:

1. The value of PPRs needs to be clearly communicated in R&D organisations. They should not be viewed only as a (bureaucratic) requirement, but as an important learning event for the NPD team and the wider organization (Table 4, point 1);
2. The timing, location and duration of PPRs should be carefully chosen to maximize learning. Management discipline is required to ensure that PPRs are given a high enough priority (Table 4, points 2, 3 and 7);
3. The core cross-functional NPD team and selected additional participants (e.g. suppliers) are required to ensure broad discussions. Management attendance for the presentation of the results is recommended to demonstrate the emphasis placed on an effective PPR and to give recognition to the achievements of the NPD team (Table 4, point 4);
4. A professional or skilled moderator can more effectively create the right atmosphere and guide the discussions in a PPR than a project leader. “Tools” such as cause-and-effect diagrams and “personal satisfaction curves” are likely to help generate and exchange more knowledge than simply discussing what went well and what could have been improved (Table 4, points 5, 6 and 10);

5. The preparation for a PPR should be conducted by the moderator and project manager together and should build on the experience gained at previous PPRs (Table 4, points 8 and 9);
6. 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 active job rotation or the creation of project teams with experienced as well as junior members of staff. The presentation of the results of PPRs to management and the leaders of other project teams are more effective methods than reports and they stimulate social interactions, which CoPs theory indicates is so important for knowledge exchange (Table 4, points 11 and 12);
7. PPRs should be used to identify where the experience from the completed project is relevant to current projects. This should lead to specific action points for current projects, where clear responsibilities to transfer the learning need to be defined. Through aiming to generate a number of specific action points, the project-to-project learning can be made more tangible, which in turn will quickly demonstrate the value of a PPR to both the participants and the members of other NPD project teams (Table 4, points 13 and 14);
8. Management needs to encourage informal interaction between NPD teams and the use of the metaphors and stories to disseminate learning. Currently metaphors are not documented or disseminated and so project-to-project learning opportunities are being lost. The moderator of the PPR could focus on metaphors and story telling as a way of improving dissemination (this point arose not from Table 4 but from the investigation of the second research question).

CONCLUSIONS

This article presented an in-depth study of post-project reviews at five manufacturing companies. Building on the ideas in the literature, data were collected from company documents, in interviews, and through observing PPR discussions. The contribution of the research is:

- It consolidated the findings on PPRs in the extant literature;
- It used multiple sources of data to ensure that a valid understanding of PPRs was developed;

- It probed the role of tacit knowledge in NPD learning, which has not been done before;
- It generated a set of recommendations for practitioners and researchers.

Overall, the authors hope this article will stimulate other researchers to focus on PPRs because project-to-project learning in NPD is crucial and researchers need to know more about how to stimulate and disseminate knowledge.

NOTES

¹The German traffic ministry allocates penalty points for driving offences from an office in Flensburg.

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Learning from Post-project Reviews : A Cross-Case Analysis

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