

# An Overview Of The Practitioners, Processes And Products Project<sup>1</sup>

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*An overview of the work of a research project is useful because it can provide the reader with a clear introduction to that project. This paper provides such an overview for the work we have conducted as part of the Practitioners, Processes and Products (PPP) project.*

*Process assessment and improvement models have increased in prominence, and a number of standards or awards for quality have been introduced. While we accept the important contributions of these models and standards, we also believe that the human factors in the processes have not been properly examined. The PPP project focuses on human factors and their relationship to the implementation of software process improvement programmes.*

*This paper describes the empirical 'breadth' and 'depth' of the project, summarises the main arguments that underpin the project, reviews the publications to-date, provides a 'profile' of the companies involved in the main study, and presents some preliminary findings.*

## **1. INTRODUCTION**

It can be difficult for a reader to develop a clear understanding of the direction and contribution of a research project when the various outputs of that project are published across a number of different journals, conference proceedings or books; and published at different times. An overview of the work of a research project is useful because it can:

- Provide the reader with a clear introduction to the research.
- 'Position' the research relative to other work.
- Provide a broad context within which to 'position' particular publications *within* the project.
- Provide an insight into the 'depth' and 'breadth' of the research.

The purpose of this paper is to provide such an overview for the work that we have conducted as part of the Practitioners, Processes and Products (PPP) project.

## **2. PRACTITIONERS, PROCESSES AND PRODUCTS**

Over the years, process assessment and improvement models have increased in prominence (Wiegiers 1998). These include the Capability Maturity Model (CMM) (Paulk, Curtis et al. 1995), the People Capability Maturity Model (Curtis, Hefley et al. 1995), SPICE, and the Personal Software Process (Humphrey 1994). There has also been the introduction of a number of standards or awards for quality, the most notable being the ISO standards, the IEEE standards, and the Baldrige National Quality Award (with its European equivalent). While we accept the important contributions of these models and standards, we also believe that the human factors in the processes have not been properly examined. Indeed much of the academic work conducted in this area is directed at the development and validation of models and standards (see (Gray and Smith 1998) for a brief critique), with little attention being directed at strategies for *implementing* software process improvement (SPI) programmes. Against that, practitioners are clearly interested in the implementation issues (as demonstrated, for example, by the number of companies who volunteered to be involved in this

project; *cf.* (Paulish and Carleton 1994; Goldenson and Herbsleb 1995; Stelzer and Mellis 1998)).

The PPP project is investigating practitioners' attitudes to software quality, and the effects these attitudes have on SPI programmes to improve software quality. The project is a development of previous research conducted by two of the project's members (e.g. (Hall 1995; Wilson, Petocz et al. 1995; Hall 1996)) who have previously investigated software quality assurance (SQA). The project began, in 1997, as a pilot study, and subsequently received UK research council funding for a more thorough study. The investigations have consisted of case studies of 25 different companies from two different countries (and, for example, including contributions from over 200 practitioners from the 13 companies involved in the main study). A number of different research methods have also been used, such as the conduct of 43 peer-group discussions and a survey of approximately 70 companies (these are discussed in more detail in subsequent sections).

### **3. THE MAIN ARGUMENT OF THE PPP PROJECT**

The main argument of the PPP project is that:

- The attitude that a practitioner has toward quality and toward quality mechanisms will influence that practitioner's *behaviour* toward quality.
- This behaviour will have an impact on the quality of the software that they produce.
- Developers, project managers and senior managers often have different attitudes toward quality.
- Differing attitudes can lead to conflicts between these different types of practitioners.
- Conflicts disrupt the design and implementation of an SPI initiative.
- One type of practitioners' attitudes can be affected by the other types. (For example, while a senior manager may impose a quality mechanism, they may encourage evasion of that mechanism when a project deadline approaches.)
- Understanding the different attitudes to quality between types of practitioners, and 'aligning' the attitudes of developers and managers, are precursors to successfully implementing SPI programmes.

### **4. A REVIEW OF PPP WORK, AND RELATED WORK**

Two appropriate publications with which to begin this review are a pair of papers (Hall and Wilson 1997; Hall and Wilson 1997) that report on some of our preliminary investigations. These papers are the core papers for the PPP project because they lay some of the empirical, theoretical and methodological foundations of the project. (Together with (Wilson and Hall 1998), these three papers report on the pilot studies for the PPP project.) The 'point of departure' for these two papers is the assertion that there is very little evidence of practitioners' views being sought or incorporated into the implementation of either industry-wide or organisation-specific initiatives. For example, in (Hall and Wilson 1997) we write that:

“The impact of practitioner attitude is frequently overlooked during the development of new quality initiatives.” ((Hall and Wilson 1997), p. 180).

The two papers report on three specific aims:

- To establish practitioners’ experiences about quality.
- To identify practitioners’ concerns about quality
- To explore the practitioners’ attitudes to, and experiences of, quality initiatives.

Case studies of five companies were conducted. For each case, information was collected through informal discussions with peer groups of developers and, separately, informal discussions with peer groups of middle managers. Also, demographic information was collected via a short interview with the company’s quality manager.

An important finding from the study was a recognition that subsequent studies should also include discussions with senior managers. The study also identified industry-wide and organisation-specific issues, and made recommendations for addressing some of these issues.

A third paper (Wilson and Hall 1998) complements and extends the work of the core papers (Hall and Wilson 1997; Hall and Wilson 1997). This third paper develops the relationship between practitioners’ attitudes and the possible affects of these attitudes on the implementation of SPI programmes. The paper also describes the use of the Repertory Grid Technique (RGT) (Fransella and Bannister 1977) for the investigation of attitudes.

The main investigations of the PPP project have been considerably more ambitious than the pilot studies. In particular, the PPP project has:

- Investigated more companies.
- Conducted more focus groups.
- Included senior managers in addition to developers and middle managers.
- Extended the use of the RGT.
- Conducted a questionnaire (which was completed by the quality/SPI manager of the company, in an interview with one of the researchers).
- Conducted a survey of IT companies, returning 72 complete questionnaires.

In (Baddoo and Hall 1999) we address the methodological foundations of the project. We justify the use of social science research methods in empirical studies of software engineering. Attention is directed at the three main methods used in the PPP project: the Repertory Grid Technique, the questionnaire (which was influenced by Parasuraman’s Quality Dimensions Questionnaire, e.g. (Parasuraman, Zeithaml et al. 1988)), and peer-group discussions. The paper also describes the four phases through which the PPP project has, or will, progress i.e. pilot studies, the full-scale empirical investigation, generalising the results (through the analysis of the survey), and proposing practical strategies for companies.

A second paper by Baddoo and Hall (Baddoo and Hall 1999) complements the first (Baddoo and Hall 1999) by reporting on the theoretical developments of the PPP project. The second paper (Baddoo and Hall 1999) provides:

- A PPP Quality Process Model that relates practitioners to process and to products, via behaviour and activity.
- A critical review of four models of process assessment and improvement i.e. CMM, P-CMM, SPICE and the PSP.
- A critical review of three sets of standards or awards i.e. ISO standards, IEEE standards and the Baldrige National Quality Award.
- A review of impediments to quality i.e. pressure from users and managers, the speed of change in the industry, the ‘quality culture’ within organisations, commercial motives for certification, lack of customised quality initiatives and motivational issues.

In Wilson, Hall and Baddoo (Wilson, Baddoo et al. 2000) we report on the implementation of a software process improvement programme at Company X. The improvement programme was triggered by an awareness that the company was not competing well, due to the poor quality of the product. The company was informally assessed at CMM Level 1. The case study found that, despite the software process improvement programme, the attitudes of *senior management* did not change. Indeed, we write:

“A key issue was that the problems identified in project management at Company X were never properly addressed. Senior managers failed to keep key members of staff informed of current projects and, behind the scenes, the senior management’s ethos to developing software had not changed...”  
 ((Wilson, Baddoo et al. 2000), p. 98)

Within the context of the PPP project, this case study has another, longer term, implication. In (Wilson, Baddoo et al. 2000) we argue that the developers’ perceptions of managers’ actions affect the developers’ attitudes to process improvement. In Company X, developers will have noted that the senior managers only pay “lip service” to the software process improvement programme, and the developers may, as a result, have a more negative attitude toward subsequent process improvement programmes. Thus, this case study provides an example of both the immediate and long-term consequences of a lack of senior management support to a software process improvement programme (*cf.* (Paulish and Carleton 1994; Goldenson and Herbsleb 1995; Stelzer and Mellis 1998)).

Baddoo, Hall and Wilson (Baddoo, Hall et al. 2000) is the first paper in which we report findings from the PPP project itself. The paper reports on the preliminary analysis of evidence collected via the focus group discussions. Attention, in the paper, is directed at the obstacles and motivators to successful software process improvement from the perspective of three groups of practitioners: senior managers, middle managers and developers. While individual practitioner groups identify a number of different obstacles and motivators, a small number of more general issues can be identified across the groups. These are:

- Insufficient time allocated to software process improvement. The preliminary analysis identified that this was the biggest obstacle to successful software process improvement.

- Difficulty in establishing top-level financial commitment. While strategic managers appreciate the merits of improving the process and understand the argument for investing in software quality, the organisational culture frustrates the commitment of strategic managers. Consequently, strategic managers appear to pay ‘lip service’ to software process improvement. (This has implications relating to developers’ perceptions of managers’ behaviour.)
- There is a lack of *measurable* benefit to software process improvement.
- That practitioners are, overall, very positive about the idea of software process improvement, but that companies need to develop better strategies for involving practitioners in the improvement programme.

Table 1 summarises the main publications of, or relating to, the PPP project.

## 5. EMPIRICAL EVIDENCE

Table 2 summarises the empirical evidence that we have collected from each of the 13 companies involved in the main investigations of the PPP project. Table 3 provides a summary of characteristics of these 13 companies. (A ‘\*’ indicates that the company was formally, rather than informally, assessed according to the CMM.)

As Table 2 indicates, for most companies a preliminary visit occurred. Attempts were made to conduct focus group discussions and RGT sessions for each type of practitioner in each company (although this was not possible in all companies). Where focus groups did occur, they were always attended by between three to six practitioners. (Given that the proportion of developers in a company will tend to be much higher than the proportion of managers, focus groups with developers typically have a higher number of people in each group. This also explains why there were more focus groups with developers and less focus groups with senior managers.) The RGT sessions attempted to rank people’s positive and negative opinions about processes e.g. what middle managers liked about inspections and then what they liked *most* about inspections.

For each company, a report was produced, detailing the preliminary findings for that company. Most companies returned a short feedback questionnaire asking about the usefulness of the report to the company.

For some companies, additional evidence was collected. Examples include organisational charts and archives of ‘email discussions’ between the researchers and the company representative responsible for arranging the visit to the company.

In addition to the focus group and RGT sessions, the quality/SPI manager answered an extensive questionnaire on managing software process improvement programmes. This main questionnaire was also sent to 1000 companies, with 200 questionnaires being returned. Of these 200 questionnaires, approximately 120 were returned uncompleted (with accompanying letters indicating that the questionnaire was inappropriate to the company). This is a reasonable response rate when one considers that many companies are not conducting formal process assessments, or implementing formal process improvement programmes.

<b>Publication</b>	<b>Purpose of the study</b>	<b>Empirical evidence</b>
(Hall and Fenton 1996)	<ul style="list-style-type: none"> <li>To gain a ‘snap-shot’ of the state-of-the-art in software quality programmes.</li> </ul>	Questionnaire survey of 123 practitioners from two UK companies
(Hall and Wilson 1997)	<ul style="list-style-type: none"> <li>To establish what practitioners’ quality experiences are.</li> <li>To identify the practitioners’ concerns about quality.</li> <li>To explore the practitioners’ attitudes to, and experiences of, qualitative initiatives.</li> </ul>	Case studies of five UK companies
(Hall and Wilson 1997)	(As above)	(As above)
(Wilson and Hall 1998)	<ul style="list-style-type: none"> <li>To conduct a pilot study to validate the use of the Repertory Grid Technique</li> </ul>	Case studies of four Australian companies
(Baddoo and Hall 1999)	<ul style="list-style-type: none"> <li>To justify the use of social science research methods in software engineering research.</li> <li>To ‘map out’ the phases of the PPP project.</li> </ul>	
(Baddoo and Hall 1999)	<ul style="list-style-type: none"> <li>To conduct a brief, but critical, review of approaches to software quality, highlighting how these approaches have failed.</li> <li>Summarise impediments to quality.</li> </ul>	
(Wilson, Baddoo et al. 2000)	<ul style="list-style-type: none"> <li>To investigate the software process improvement paradox i.e. that companies are not mature enough to improve.</li> </ul>	Case study of one UK company
(Baddoo, Hall et al. 2000)	<ul style="list-style-type: none"> <li>Provides preliminary analysis of the obstacles and motivators to SPI, from the perspective of three types of practitioners.</li> </ul>	Responses during focus group discussions from 10 UK companies

**Table 1 Summary of PPP-related publications**

The main questionnaire asks about company demographics, process improvement, process data collection, people management, evaluation of process improvement progress and quality certification. Appendix A of the questionnaire asks about the personal background of the quality/SPI manager e.g. educational background, qualifications and membership of professional bodies. Appendix B asks about the personal opinions of the quality/SPI manager with regards to SPI.

Co.	Preliminary visit	Focus Group			RGT			Survey			Feedback from report	Other data
		SM	MM	Dev	SM	MM	Dev	Main	Appendices A	Appendices B		
1	Yes	1	2	2	1	2	2	Yes	Yes	Yes	Yes	No
2	Yes	1	1	2	0	1	2	Yes	Yes	Yes	Yes	Yes
3	Yes	1	2	2	1	2	2	Yes	Yes	Yes	Yes	Yes
4	Yes	1	2	2	1	2	2	Yes	Yes	Yes	Yes	Yes
5	No	1	1	1	1	1	1	Yes	Yes	Yes	Yes	Yes
6	Yes	1	2	2	1	1	2	Yes	No	No	Yes	No
7	No	1	1	1	1	1	1	Yes	Yes	Yes	Yes	No
8	No	1	1	1	1	1	1	Yes	Yes	Yes	Yes	Yes
9	Yes	1	1	2	1	0	2	Yes	Yes	Yes	Yes	Yes
10	Yes	1	1	2	1	2	2	Yes	Yes	Yes	Yes	Yes
11	Yes	0	1	1	0	1	1	Yes	Yes	Yes	Yes	Yes
12	Yes	1	0	1	0	0	1	Yes	No	No	Yes	Yes
13	Yes	1	1	2	1	1	2	Yes	Yes	Yes	Yes	Yes
Total		12	16	21	10	15	21					

**Table 2 Summary of data collected**

Company	CMM Level	Hardware/ Software producer	UK or Multi-national	SE (people)	SE Size (people)	Age (years)	Software type
1	1*	HW/SW	MN	>2000	>2000	>50	Real-time embedded
2	1	SW	UK	100-500	100-500	20-50	Business systems
3	1	HW/SW	MN	>2000	500-2000	>50	Real-time embedded
4	1	HW/SW	MN	>2000	500-2000	>50	Real-time embedded
5	4*	SW	MN	>2000	>2000	10-20	Real time
6	3*	SW	MN	>2000	>2000	10-20	Real time
7	1	SW	MN	>2000	>2000	20-50	Packages
8	2	SW	UK	10-100	10-100	5-10	Business systems
9	3	SW	MN	10-100	10-100	10-20	Real-time embedded
10	1	SW	MN	>2000	10-100	10-20	Embedded, Systems software
11	2	HW/SW	MN	500-2000	11-25	20-50	Real-time embedded
12	1	HW/SW	UK	100-500	<10	20-50	Embedded
13	3	SW	UK	100	40	10-20	Business systems

**Table 3 Summary of companies involved in the study**

## 6. PRELIMINARY FINDINGS

The project is moving from a data collection and analysis stage into a reporting stage. We are exploring the following issues:

- There is a difference between what motivates developers (according to those developers) and what senior managers think motivates developers. This has implications for how SPI programmes should be designed and implemented. For example, a participative approach to SPI may help practitioners to understand each other's motivators better.

- Local opinion, particularly that of local experts, appears to be more credible to practitioners than empirical studies of third-party sites. This may help to explain the difficulty in transferring research findings into industry.
- Companies may not be ready to undertake SPI. We are developing and validating a framework to help companies conduct a self-assessment of their *readiness* to undertake SPI. This framework addresses context, inputs, process, and products.
- There are a number of ‘core’ organisations that are actively, and successfully, involved in SPI. We are compiling a set of core organisations, and such a ‘data set’ could be used to validate some of our findings.
- The maintenance process does not appear to be addressed by software process improvement models, particularly the CMM. Also, there appears to be a close link between maintenance and requirements.

## 7. CONCLUSIONS

A review of the work, central and peripheral to the PPP project, indicates that:

- The PPP project presents a stream of research that has evolved from investigating software quality assurance programmes to investigating software process improvement programmes. This is in response to academia’s and industry’s interest in software process, where software quality management is considered to be part of a broader interest in software process, and project and product outcomes.
- This research has been conducted over several years, has involved some 25 different companies from two different countries, for case study research, and has involved over 70 companies for survey-study investigation. For the case studies, the research has investigated the opinions of over 200 developers, middle managers and senior managers, through the conduct of 43 peer-group discussions and RGT sessions.
- The publications have variously reported on methodological issues, theoretical foundations and developments, and empirical evidence.
- Preliminary findings relate to a number of areas e.g.. motivating practitioners to change, problems with using evidence to convince practitioners, and the readiness to undertake SPI, and the lack of SPI attention to maintenance issues.

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