Title: TENSIONS AROUND THE ADOPTION AND EVOLUTION OF SOFTWARE QUALITY MANAGEMENT SYSTEMS: A DISCOURSE ANALYTIC APPROACH

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TENSIONS AROUND THE ADOPTION AND EVOLUTION OF SOFTWARE QUALITY MANAGEMENT SYSTEMS: A DISCOURSE ANALYTIC APPROACH

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ABSTRACT

This paper reports some results from a project to uncover the non-technical factors that affect the adoption and evolution of Software Quality Management Systems (SQMS). The data which the paper discusses comes from interviews with people involved in the quality effort in four different companies. Our approach to data collection was to use semi-structured interviews and to encourage interviewees to talk about their experiences of quality management and software development in their own organisations. We analysed this data using discourse analysis, informed by ethnographic observation, and identified a number of themes, one of which was the tensions that exist around the adoption and evolution of SQMS. In this paper, we present and discuss our approach to discourse analysis and some results that illustrate the tensions we found. We hope, thereby, to demonstrate how software engineers may use a technique from the social sciences to better understand their own practices.

1 BACKGROUND

This paper describes the collection and analysis of qualitative empirical data to investigate the non-technical factors influencing the adoption and evolution of software quality management systems (SQMS). We collected a variety of data through our project, but in this paper we concentrate on data from semi-structured interviews conducted with quality managers.

The importance of non-technical factors in the success of software engineering projects has been recognised for many years (e.g. DeMarco & Lister, 1987; Curtis et al., 1988). Few empirical studies have been reported that look at the impact of non-technical factors on software development practices, although work in the area is growing (e.g. Baddoo & Hall, 2002b) and the significance of studying the human aspects of software engineering through qualitative methods is receiving more attention (e.g. Seaman, 1999; Seaman, 1998). We began our project because of our concerns that technical innovations did not appear to be producing better quality software systems. Our particular focus was on the effect of quality initiatives such as ISO9000...
certification schemes, and the social factors affecting the success, adoption and evolution of SQMSs in response to those schemes (Hall et al., 1993; Hovenden et al., 1994; Sharp et al., 1999).

In the remainder of this introductory section, we provide some background on software quality management systems, and the wider project of which this work forms a part.

In the next section, we introduce the methods used for data collection and analysis. Then in Section 3, we present the results of discourse analysis that led to our focus on the tensions around the adoption and evolution of SQMSs. This section includes example discourses from our data that illustrate the tensions we found, where these tensions occurred and where they did not occur. In section 4 we discuss our results in the context of other relevant work. Finally we share some observations about the use of discourse analysis in this context.

1.1 Software quality management systems

An SQMS is intended to make the process of software development visible and public. This is partly about accountability, but, more pragmatically, makes knowledge (especially that relating to the practice of developing software) communal, minimizing the problems arising when team members are away, or have left. It also helps to make the process visible to those who have not been involved in the development, such as senior managers, auditors and customers. An SQMS makes the process auditable because it provides guidelines, or benchmarks which can be tested against, and it provides some assurance of adherence to house style. This fulfills a range of requirements, including indicating to customers that certain standards are being met, strengthening a market image by ‘branding’ through conformance to certain standards. Hence the introduction of an SQMS can reinforce management control as well as enforce internationally established guidelines.

The following are quoted from (ISO8402, 1994) which provides internationally standardised definitions of quality terms:

- **quality**: the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.

- **quality policy**: The overall quality intentions and direction of an organisation as regards quality, as formally expressed by top management.

- **quality management**: That aspect of overall management function that determines and implements quality policy.

- **quality system**: The organisational structure, responsibilities, procedures, processes and resources for implementing quality management.

This set of definitions have arisen from a desire to have organisational and managerial forms of quality management, following on from the works of gurus, such as Deming (1982), Juran (1988), and Crosby (1979). This movement in turn led to certification schemes such as BS5750 (1987) and ISO9000, (also known as ISO EN BS 9000). Other, more explicit models have also been developed, such as the Capability Maturity Model (Paulk et al., 1997) and later the People CMM (Curtis et al., 2002) and CMMI, SPICE (El Emam, 1998) and Total Quality Management (Oakland, 1994).

1.2 The SoFEA Project

The SoFEA project aimed to identify non-technical factors influencing the adoption and evolution of quality management systems. It began in 1993 when we raised issues regarding SQMSs and sought stories from attendees at a conference on software quality. From this initial contact, we collaborated with five companies to explore the issues further. In each case, we
interviewed the initial contact. Further involvement with the organisation varied, depending on the opportunities that presented themselves. In one case, this led to a one-week ethnographic study which included participant observation.

The project has looked specifically at the introduction of software quality management systems in the context of certification to standards such as ISO9000 (2000). We have used qualitative data collection and analysis. Our analyses so far have underlined the importance of involving influential developers in the production of the SQMS (Hovenden et al., 1996), discussed observations on the effect an organisation’s culture may have on attitudes to software quality (Sharp et al., 1999), and presented some reflections on the implications for software engineers of our interdisciplinary approach (Sharp et al., 2000).

2. RESEARCH METHOD

In this paper we focus on data from the initial interviews with quality managers. We do not consider the data gathered from the company where we conducted participant observation, since the type and amount of data available for this company is very different from the other companies, and this would lead to an imbalanced view. The data collected was analysed using discourse analysis.

2.1 Data collection

Over a period of six months, we interviewed the four quality managers who had volunteered to share their experiences after the conference. Each interview was approximately 3 hours long. For all of our visits we took an ethnographic approach in that we paid attention to the physical and social environment of our interviewees, and any clues we could observe about the organisational environment (in addition to any comments made by the interviewee) (see, e.g. Hammersley & Atkinson, 1995). This led us to collect data such as copies of notices on pinboards, technical documentation, and marketing literature.

The interviews were semi-structured. We made the tone as informal and conversational as possible and did not adhere to a pre-determined question order because we wanted to encourage the interviewees to talk about issues that they saw as important in their work and thence to find out their and their company’s attitudes to quality. We did not ask direct questions about the factors affecting the quality management system, but had some initial questions to start the interview, a list of topics that we wanted to be covered, and some follow-up questions to be used if the interviewee did not mention a topic of interest spontaneously. In addition, we had some specific questions that we asked of all interviewees to elicit particular individual or company attitudes. The list of initial, specific and follow-up questions, are shown in Table 1. The topics of interest that we wanted to cover were:

- the organisation’s structure, main business, training opportunities, market attitude, and market position
- the history of the organisation’s SQMS
- the interviewee’s responsibilities and attitude towards quality
- publications, gurus, conferences or any other fora which influence the interviewee
Table 1 The questions and topics used in semi-structured interviews

<table>
<thead>
<tr>
<th>Initial questions asked of all interviewees</th>
<th>Specific questions asked of all interviewees</th>
<th>Follow-up questions used as necessary to cover topics</th>
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<tbody>
<tr>
<td>What is your area of work?</td>
<td>Are there any mottoes which fit your team’s work?</td>
<td>What do you regard as the most important aspect of your work?</td>
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<tr>
<td>What is your official job title or titles?</td>
<td>What publications do you read? Do you feel that they influence you very much?</td>
<td>If you were writing a book about your job what would the chapter headings be?</td>
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<tr>
<td>Please tell us the story of your experience with the company’s QMS?</td>
<td>Within your field do you have a favourite guru?</td>
<td>How do you see your department/area evolving in the next five years?</td>
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<td>What methodolgies do you prefer to use?</td>
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<td></td>
<td></td>
<td>How do you see your particular job evolving in that time?</td>
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<td></td>
<td></td>
<td>What languages (computer) do you prefer to use?</td>
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<td>Do you think ‘quality’ is important?</td>
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<td></td>
<td></td>
<td>Do you feel that team-building is part of your job?</td>
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<td></td>
<td></td>
<td>How do you go about it?</td>
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<td>How would you describe your company’s attitude to ‘quality’? Is it the same throughout the company?</td>
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<td>Do you purchase from other suppliers? What’s the worst case scenario that you have experienced?</td>
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<td>What software and hardware do you prefer to use personally? Why?</td>
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<td>You’ve been offered a contract with a 10% risk or reward option for completing</td>
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<td>On time</td>
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<td>On budget</td>
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<td></td>
<td>Do you take it? Why/why not?</td>
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<td></td>
<td>Say it’s Friday afternoon and you are going on holiday for two weeks. You have to ensure a project’s success while you are away – what action do you take? What if the project is running over time and budget?</td>
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<td>If you had to choose between being sure that a project would deliver a high quality product, and being sure that the project would finish on-time within budget, not necessarily with a low quality product, but you couldn’t guarantee anything, what would you do?</td>
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<td>Do you do testing? What type?</td>
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<td>What kinds of staff training do you offer?</td>
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<td>How is your work reviewed?</td>
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<td>Please tell us something about your own training generally?</td>
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</table>

The interviews were audio-recorded. Before recording began, we asked the interviewee if they were comfortable with this approach, assured them that the recording could be stopped at any time, and that if we wanted to quote any of the data it would be anonymised. This was acceptable in each case.

For each interview, two of the three researchers were present: one was principally in charge of conducting the interview, while the other made notes and ensured that the audio recording equipment was working; the latter researcher attended all interviews and helped to maintain a level of consistency through them.

2.2 Data analysis

The interviews were transcribed and themes were extracted from the data using discourse analysis, informed by the ethnographic data. We used discourse analysis to focus on the
structures of text to explore people’s attitudes and intentions, and ethnographic data to inform our interpretations by providing a context and framework. For example, in one organisation we visited, there was a series of quality certificates hanging on the wall of reception which related to another section in the company. This may have indicated that the company culture would be accepting and supportive of quality initiatives. However, although one of the topics to be covered was the influences on the interviewee, the existence of these other quality activities were not mentioned. Other clues elicited from the ethnographic approach concerned a company’s attitudes to building security, adherence to rules, formality, and hierarchical structure.

Discourse analysis is concerned with the collection and analysis of spoken or written data. It takes many forms (Wetherell et al., 2001) and is predominantly used in the social sciences where the detail of its application is contended (e.g. see Antaki et al., 2003). It considers what people do with words and how they achieve certain ends (e.g. Potter & Wetherall, 1992; Gee, 1999; Lee & Poynton, 2000). For example, it is via language-in-use (cf. Gee) that people reveal, perhaps inadvertently, implicit knowledge and meaning. This knowledge and meaning might well be different to what their companies would like to portray or what they themselves might rationalise. For us the techniques of discourse analysis were taken to be suitable tools of enquiry because we wanted to uncover implicit knowledge regarding software quality management systems. In our analysis, we were therefore interested in what words our interviewees used and when. For example one of our interviewees when asked about his definition of quality answered by using ‘we’ and ‘our’ rather than ‘me’ and ‘my’. When he used ‘we’, he was referring to the organisation, and this showed a very close alignment by this quality manager to the organisation and its goals.

We looked for structural features of the text, i.e. the field (topic), the tenor of discourse, and all references to ‘quality’. At another level, we were also interested to see what comments were made by the interviewees spontaneously, and which topics were introduced by them, as this was an indicator of how important the interviewee regarded it. The data collection approach we used meant that interviewees were encouraged to express their own attitudes and beliefs, and what they chose to say or not to say was just as insightful as how they said it.

We proceeded with our analysis one interview at a time. First, it was transcribed, and then we tried to identify themes, attitudes or other noticeable traits that might indicate the factors we were searching for, i.e. non-technical issues that had influenced the adoption and evolution of this organisation’s quality management system. Each of the three researchers tackled the transcription independently, and then we came together to discuss our findings. We did not use any automatic tools or special notations for logging and annotating data, preferring to audio-record and transcribe interviews for later annotation and analyses with observations and artefacts available from our ethnographic approach. The classifications we each identified were recorded and discussed to check each other’s analysis and ultimately to find a consensus. One of the reasons for conducting analysis this way was that we were constrained by both practical considerations of speed and budget and by an implicit goal that our approach be accessible to and usable by the software engineering community – including ourselves!

3. RESULTS

A set of recurrent themes were highlighted by the interviewees in their data. This included organisational coherence (indicated by the attitude of the interviewee to the company); degree of involvement from developers in the quality process; motivation for developing a quality management system at all; the (lack of) formal external influences such as quality agencies; and
informal influences such as those from peer networks and colleagues. One theme that emerged strongly was the existence of tensions reported by the interviewees around the process of quality management system adoption and evolution. It is this theme that we concentrate on in the rest of the paper.

To illustrate our approach we present in the next section a detailed example of how we used discourse analysis to identify and investigate the tensions theme. Following this, we present summaries of our findings from each company. For confidentiality we do not use the companies’ real names in the following discussion, and refer only to companies A–D. Occasionally words used by the interviewee which may have identified the company are replaced by equivalent words placed in angle brackets <>.

3.1 A detailed example of our use of discourse analysis

This section traces part of the discourse analysis of Company A in detail. It aims to show how the theme of tensions and our more detailed conclusions about it were identified and investigated. The reader should be aware that reporting our analysis as follows with post hoc ordering and commentary tends to make the conclusions obvious. However, we did not initially set out to investigate tensions; it was not a hypothesis being tested and it was not an obvious issue from an ordinary reading of the discourse. This theme arose from the kind of analysis presented here, but in reporting our analysis it is difficult to convey the implicit nature of what we uncovered.

Furthermore, our written account does not fully cover two practices we employed during our analysis. Firstly, we paid attention to the way words and phrases were used, and the way in which the words were spoken (e.g. sarcastically, enthusiastically, hesitatingly, etc.) which can reveal more than simply the words themselves. Secondly, we took account of the physical and social context of the meeting (e.g. whether it took place at our collaborator’s premises and what else was going on in the immediate environment).

The interview began by us saying

"Start with who you are and what you do"

The interviewee gave us a description of the company and the business they are in. This business is to hire out large vehicles containing specialised software-intensive equipment for scientific analysis on the move. This equipment and its software are created, maintained and supported in the field by their employees. This was the factual part of his response, but using discourse analysis we can learn more from his answers. For example it was interesting to note that he interpreted the "you" of the sentence to mean the company rather than himself. We were also able to determine (tentatively at first) that the interviewee felt real pride in the service that the company offers. The following comments were offered by him when talking about what the company does. We have underlined words and phrases which, we concluded, collectively reveal his pride in what the company does.

'we hold a large collection of expensive equipment'
'I don’t think there’s anybody else who’s got that expertise'

These remarks were not ‘obvious’ responses to the question originally put. For the interviewee they were part of defining what the company was about. Something else is being conveyed other than the facts of owning a large collection of expensive equipment and having no competitors with the company’s expertise. Having focussed on these unsolicited statements we tentatively identified the feeling of pride. His later comments, some of which we discuss below, supported this position.
The company owned and ran two vehicles. At the time of interviewing, these could not be operated full-time, but were run six months at a time:

‘owing to financial constraints we can’t afford to run it, which is sad’

The profession of sadness is the obverse of the feeling of pride and strengthened our tentative identification of it: again, independent of the fact offered, the comment exposes his view that the company is falling short of his aspirations for it.

And later, when it was suggested that commercial companies might offer a similar service to their own, he reacted quite emphatically, not waiting for the question to be completed:

‘Do you feel that the service that the commercial people offer is the same as...?’

(jumps in)

‘No they don’t, they just give you a <vehicle> and the handling side (.). I don’t think there’s anybody offering a fully instrumented <vehicle>’

Not only was the interviewee eager to make his point, evidenced by not waiting for the end of the question, but also by using the word ‘just’ he stresses that the service offered by these organisations is inferior to Company A’s.

At the point in our analysis when we considered this interaction, we had begun to look for evidence to support or reject the conjecture that there was considerable pride in the company. We had to remain vigilant that we were not distorting our analysis to fit a mere notion. This is where our practice of first independently analysing the data and then doing it together in a spirit of challenge and verification is vital. Despite challenging each other, we determined our conclusion that our interlocutor’s pride in his company’s activities was beyond doubt.

Later in the conversation, discussion turned to software development and its quality management. The interviewee talked enthusiastically and at some length about their software. For example:

‘...and scientists are talking about logging things 8, 16, 32 times a second.’

‘That’s a lot of data’

‘It is for a general purpose system which ours is...’

Here we again see pride expressed in the company’s service, but this time in the software they produce: this is a general purpose system, i.e. one that is used by many different scientists, yet it can log (and do simple analysis) on large amounts of data.

The interviewee himself introduced the subject of the SQMS adoption process, while talking about scientific calculations. He seems reluctant to talk about it, and his tone changes. He hesitates about what to say, and then explains his involvement in a very careful way – he says:

‘I was volunteered for this in my absence’

Note the choice of words we have highlighted: he says he ‘was volunteered’. By this usage he is distancing himself from the process of developing the software quality management systems by indicating that he didn’t want to be involved, and that he doesn’t feel any ownership of it. He further distances himself from his involvement by giving the unnecessary detail that he was absent when the decision to ‘volunteer’ him was made. (It emerged later that the decision was because he had prior experience, but here it was reported in such a way that denied the wisdom of the decision.) However, when asked about the status of the process he does take ownership by using ‘I’.

‘So you haven’t got certification yet? ...’
I’m still working towards it, do you want the gory details? ...

This is a surprising change. The interviewer intended ‘you’ in the question to be plural, and the interviewee’s response may have been triggered by a misinterpretation, but in the context of the conversation this was unlikely. Not only has he taken ownership, he has taken sole ownership. But note also the words he uses to ask if we want to know more. He also expresses doubt and some cynicism about the reasons for wanting to gain certification, using again some careful and very laboured wording that distances him from the development of the software quality management system:

‘... it was felt that it would be a good thing in restricting outside competitors who could bid for it if we could write in quality certifications…’

‘I’m not convinced what the Senior Management’s real reasons are for wanting QA certification but the way it has been sold is that if we have the magic letters BS5750 we will be able to compete better, we will be able to say to people ‘we are the best’, and that is the only way it’s been sold there is no suggestion that it might make our work more interesting’

Here is a clear indication of a tension regarding the introduction of a software quality management system. It is not just personal (as in ‘I’m not convinced’) but the use of the passive voice which makes the responsible decision-makers anonymous both distances him from the policy and questions it. The implication of the second comment is that Company A couldn’t say they are the best without the certification, yet our interviewee clearly believes that they already are the best (see above). The use of the term ‘magic letters’ and the claim of inappropriate selling of rationale derides the very development of an SQMS for obtaining certification. However, it is interesting to note, that he claims that he is not against quality or certification of quality processes per se, just the way Company A is going about it:

I think my feeling towards QA is that quality would be a good thing, it would help our job, but the last thing I want is somebody saying we’re doing it so we can get a bit of paper.

At the end of the interview, he took us on a tour of one of the vehicles and showed us the living and working conditions, underscoring his pride and enthusiasm for the work he does.

3.2 A Tale of Four Companies

We now summarise our findings of the tensions around the evolution and adoption of software quality management systems. These findings combine the results of our discourse analysis with facts and opinions stated explicitly by our collaborators and assessed by us as useful statements for setting the scene. The discourse analysis is not provided below, but the occasional explicit statement is quoted.

Company A

Company A’s main business was to provide computing services to scientists. At the time of interviewing, Company A had only just started developing their SQMS, and was also undergoing some restructuring, including relocation. Here we spoke to one management-level employee involved in the development of the SQMS; no quality manager as such had been identified.

The need to develop an SQMS was driven by a belief that certification to ISO9000 was required because of commercial pressures. This drive was seen by the staff as an imposition from above which led to resentment. When we visited the company, a group of engineers, including our interviewee, were writing down the procedures already in operation. This was seen as unproblematic in itself (except that it was viewed as a ‘waste of time and effort’ by many
people), but there was concern about the next step, when they identified certification requirements that the company did not meet. For example, writing new procedures to fill the gaps in current practice would require ‘changes in working practices’, which would not be welcomed. In this company there was a strong feeling of pride in the service that they offered and in this sense there was no perceived requirement for certification of any kind.

**Company B**

Company B was a large avionics organisation which had been heavily involved in the defence industry for many years. Company B’s SQMS had just moved into everyday use. Our interviewee had been involved in developing quality systems in a number of companies and was responsible for quality procedures within Company B.

Although the requirement for quality standards had existed for many years, it was the need to conform to ISO9000 which led to the introduction of a unified quality management system. A sense of injustice was felt by the imposition of a new quality system, through lack of consultation. This led to ‘humorous annotations’ to posters exhorting the staff to improve quality. The quality manual (i.e. its procedures) had evolved through various versions. Initially, it was ‘particularly opaque’ and the relevance of its contents to the engineers was not recognised. In the final document, mandatory information, i.e. this ‘shall’ happen in these circumstances, was backed up by wise engineers’ comments, explaining why it was important to do things in a particular way. This may have helped overcome the resentment, but the document appears to have become unmanageable, and they are left with a document which allows a marked degree of flexibility: ‘if you don’t specifically say that you’re using something different, then this <quality manual> will apply’.

**Company C**

Company C was a large software house with international links. Its SQMS was mature and had been operating for many years. Our interviewee was the quality manager for one of the company’s sections; other quality managers existed in other sections. The company chairman was committed to quality and exerted great influence on staff.

This company has a high-level SQMS which outlines how quality management should be implemented in a general sense, with the details being left to the individuals working in specific areas. This was summed up by his comment that: ‘You write down what you need to write down but no more’. The attitude within the company is that staff need to be involved in developing the SQMS, that they understand best how to get the job done, and that they need to be free to do it. Staff are encouraged to make suggestions for how to improve quality in their part of the company. There is also a clear message that the quality manual should reflect actual practice, rather than idealized intentions. Any new procedure which is suggested is trialled first, and if it is successful, it can become part of the quality manual.

The quality management system began life as an ‘encapsulation of useful information’ which had been compiled in response to developers. This early ‘grass roots’ move toward documenting useful information seems to have merged seamlessly with a later, more formally introduced quality regime. This came from senior management in the mid-1980s when everyone in the company was sent on a quality course. At the same time, ISO9000 registration was being sought, and the two initiatives supported each other.

Our interviewee emphasized that a sense of pride is essential. He specifically described this in terms of clarity of purpose, and of public acknowledgement, for example in the form of promotional mottos and the annual staff quality awards to recognise any exceptional contribution to quality.
**Company D**

Company D had been a subsidiary of a larger, non-UK company for many years and was the only subsidiary whose main business was software development. Company D had a mature SQMS which had been operating for many years. We interviewed the quality manager who had been in the company for 16 years and who also had experience of running his own software company.

They had adopted quality management early on. The SQMS was developed iteratively and is continually improved. The system is substantially written by people ‘on the ground’ since ownership is seen as an important factor. They were the only software house owned by this company, although software development pervaded many other subsidiaries. There were thus many influences brought to bear on the development of their quality procedures. The SQMS currently in use is divided into prescriptive procedures, and guidelines.

The emphasis in this quality manager’s mind was on maintaining the high profile of quality, and encouraging an attitude to ensure that quality never slips and that a long term view of the company’s business is maintained. A salutary tale was told of another arm of the business, also in the computer industry which had decided not to try for TickIT certification, when it already had ISO9000. The board of this division decided that there was no reason to expend the effort necessary, but our interviewee believed that this gave ‘a public statement of lack of commitment to to quality’. His interpretation was justified when the division picked up a ‘major discrepancy’ on a routine assessment.

### 3.3 Summary of findings about tension

Tension can be productive, but most examples identified above are counter-productive, acting as barriers. Tension appears to be present under the following circumstances:

- Inadequate or obviously unreasonable explanation is given regarding the need to introduce an SQMS (Company A);
- There is a general lack of consultation with staff concerning the introduction and subsequent development of the SQMS (Company B);
- Procedures which ignore current practice are imposed with no explanation of their rationale (Company B);
- Existing pride in the company is questioned or undermined by undervaluing expertise (Companies A, B)
- Procedures are written in a rigid fashion, ignoring the practicalities of day-to-day working (Company B);
- Company commitment to quality falters (Company D).

Tension appears to be resolved or at least alleviated under the following circumstances:

- The need for a quality manual, and for quality initiatives, is accepted by all staff (Companies C, D);
- Staff who have to implement the procedures write them (Companies A, C, D);
- The manuals themselves include explanation and varying levels of insistence, or are not entirely prescriptive (Companies B, C, D);
- The manual is flexible and allows decisions to be taken ‘on the ground’ (Company B);
- The company’s commitment to quality is visible and maintained (Companies C, D).
4. DISCUSSION OF RESULTS

In this section, we discuss our results in the light of others' work in empirical investigations of software process improvement and organisational change literature.

4.1 Managers and workers

The existence of tensions highlights the importance of employee relations, and the need to include employees in discussions. These issues have been identified by others, and are sometimes portrayed as being tensions between ‘management’ and ‘workers’. However, in our case, all of our interviewees were ‘quality managers’, a role that does not fit neatly into traditional organisational structures. In two cases, the quality manager was a senior developer, but still engaged in the day-to-day hands-on activity of producing and maintaining code (Companies A and B). In the other two cases (Companies C and D) the quality managers had other development management duties as well as managing the quality system. None of our interviewees could be classed as ‘senior managers’, and nor did they class themselves as such. Reviewing the summary of our findings with this in mind, it seems that companies C and D have on the whole found ways to alleviate tensions while companies A and B have not. Our interviewees in Companies A and B were senior developers who also had management responsibilities, while in Companies C and D they were quality managers who also had a management role in development projects. This subtle but important difference may explain some of our findings, but in a sample of four companies, this division may be coincidental. Another factor that is more likely to be influential is the maturity of the SQMSs: In companies A and D the SQMSs were more mature than in B and C, i.e. the system had been in place for a number of years.

4.2 Empirical investigations of software process improvement

Much is written in the literature about the importance of various factors for the success of quality management initiatives (e.g. Adam et al., 1981; Deming, 1986). These factors include the importance of senior management commitment, active quality leadership by managers and the inclusion of employee considerations in improvement initiatives. Empirical work in the area is scarce, but is growing. For example some empirical work has been done to identify and validate measures of critical factors discussed in the literature (e.g. Saraph et al., 1989; Black & Porter, 1996; Dyba, 2000), which incidentally throw some light on the acceptance of these factors, but do nothing to expand upon them.

We have been unable to find any work that focuses specifically on SQMSs, nor any work that uses a discourse analytic approach. However, the work of Baddoo and Hall (Baddoo & Hall, 2002a; Baddoo & Hall, 2002b) addressing motivational factors in software process improvement (SPI) has some overlaps with our work on tensions. They conducted focus groups with practitioners in 13 companies. Practitioners were divided into three categories: developers, project managers and senior managers, and each focus group was asked to discuss two questions: What are the motivators for SPI in your company? and What would motivate you to support SPI? They then used content analysis to identify motivational factors for each group, and summarised their findings in terms of a numeric count of the number of groups in each category who mentioned each factor. In summary, visible success, reward schemes, resources, process ownership and a maintainable/easy process were mentioned to one degree or another by all groups.

Apart from the number of practitioners involved, the research methods used by Baddoo and Hall were different from ours in two respects: first in the questioning of respondents. We did not ask questions specifically about the software quality management system, but allowed the
interviewees to raise whatever issues that were forefront in their minds, while Baddoo and Hall gave their focus group specific SPI questions to discuss. Second, our analysis techniques were different. We identified tensions within different phases of SQMS adoption and evolution, while Baddoo and Hall did not distinguish any such phases. We used discourse analysis which allows us to explore people’s attitudes and intentions, while Baddoo and Hall used content analysis to produce a numeric count. In addition, we used ethnographic data to frame our analysis, an aspect not considered by Baddoo and Hall.

Despite these differences in approach there are some similarities in findings. For example, top-down commitment was cited by 24% of the developer groups, and we found that tension emerges when management commitment falters. Process ownership was mentioned by all practitioner groups: 19% of developers, 25% of project managers and 17% of senior managers. In our study, tension was alleviated when staff write the procedures they have to implement, and falters when procedures are imposed.

In Baddoo and Hall’s study all groups mentioned visible success, yet no evidence arose from our data that this was an issue. The closest our data comes to this is the need for careful explanation for introducing the SQMS. Reward schemes were discussed by one of our interviewees, but were mentioned alongside mottos and badges to give a clear purpose to the group. None of our other interviewees mentioned them. The need for resources was not discussed, neither was the need for a maintainable or easy-to-use process.

4.3 Organisational Change

Our findings can also be related to the literature on organisational change. Introducing a software quality management system into an organisation is about changing the company’s culture and the way people work. Writers about organisational culture acknowledge that changing cultures is hard, and there are recognised reasons and conditions for resistance.

Buono & Bowditch (1989, p167) state that ‘if organisational members can see the inherent value of a change, they are much more likely to accept and identify with what the organisation is attempting to accomplish.’ Williams et al. (1993) also suggest that resistance will occur if the need for change is not recognised by those it will affect. Deal & Kennedy (1988) emphasise the importance of peer group consensus. All of these issues link to our finding that tensions were caused when the rationale for introducing SQMSs was not explained, or there was a general lack of consultation with staff.

Another condition likely to cause resistance is when there is increased level of uncertainty, in jobs, status, rewards, etc. This is mentioned by Williams et al. (1993) and by Brown (1995) who talks explicitly about esteem and status. Deal & Kennedy (1988) emphasise the importance of two-way trust. We found that tensions were caused when developers felt their expertise was undervalued, or when management commitment faltered.

Other tensions we found were at a lower level of detail and were specific to software quality, e.g. rigid versus flexible procedures, staff writing the procedures versus imposition from another body, etc.

5. DISCUSSION AND CONCLUSION

In this paper, we have reported some results emerging from a study of the non-technical factors affecting software quality management systems focusing on the existence of tensions around their adoption and evolution. These results were achieved using discourse analysis supported by an ethnographic stance, an approach that we believe is novel in understanding software practice.
We conclude by reflecting on our use of discourse analysis, the results we have described and further development of these ideas.

5.1 Reflections on our use of discourse analysis

Software engineers and computer scientists are trained to be systematic and explicit in all aspects of what they do, for example, in eliciting requirements for software-based systems. They are taught to eschew uncertainty and vagueness, to search for and remove omissions and ambiguity. The use of discourse analysis and the interpretation of its findings therefore present a challenge to software engineers and computer scientists whose training is for dealing with explicit facts and opinion rather than tacit knowledge. In reflecting on our use of this technique, three aspects of the application of discourse analysis that struck us as particularly challenging were:

Seeing beneath the explicit facts to find the hidden knowledge and meaning

A straightforward reading of interview transcripts will reveal explicit facts and opinions. However, it will not yield implicit knowledge and meaning. Yet, the explicit and the implicit complement each other and allow us to build up a more complete picture. We were therefore determined to identify both and used discourse analysis to reveal this implicit knowledge and meaning.

The way someone expresses themselves can reveal a lot about them and their (professional) world. This was a real benefit of using discourse analysis: it allowed us to uncover tacit information. However, as software engineers who are far more used to collecting, analysing, interpreting and using the explicit, it was difficult to see the implicit because it was so much easier to focus on the explicit.

Avoiding judgement

Following the ethnographic tradition, we strove to maintain a non-judgmental position and treated everything as ‘strange’, throughout the study and subsequent analysis. This meant pretending to ourselves that we didn’t understand much about software development or quality initiatives – except to the extent we could have a real conversation and begin analysis with a minimum of assumptions. This helped to reinforce the view that our interviewee was always the expert, but there was a balance to be struck between knowing nothing and knowing enough for our interviewees to feel that they could talk knowledgeably to us. From our experience we believe that this approach allowed our collaborators to express their own viewpoints more fully, and this therefore allowed us to gain a better perspective. We found that maintaining a non-judgmental stance was not always easy, and particularly in discussions of the data, we often had to keep each other in check.

Communicating our findings

Our collaborators had expected us to be judgmental and comparative. They regarded us as ‘one of them’ because we shared a common background, including software engineers with knowledge of quality management issues. This allowed us to enter into informed discussion with them, but our observations needed to remain impartial, and our ability to enter into such discussion may have led them into thinking that we would provide different feedback. They did not, however, feel that they had been misled as to the nature of our study.

5.2 Recommendations for avoiding tensions

In this paper, we have presented some factors affecting the adoption and evolution of SQMSs in four companies. Through our use of discourse analysis we have found that tensions exist around
this process. By comparing companies that do and those that do not experience them, we are able suggest ways in which the tensions may be alleviated or avoided:

- The need for a quality manual, and for quality initiatives, should be clearly explained to all staff;
- Staff who have to implement the procedures should be encouraged to write them;
- The manual itself should include explanation and varying levels of insistence; it should not be entirely prescriptive;
- The manual should be flexible and allow decisions to be taken ‘on the ground’;
- The company’s commitment to quality should be visible and maintained.

5.3 Future directions

We have used discourse analysis and ethnographically-informed techniques in other related research, for example, in understanding the impact of constituencies and communities in the development of technical ideas (Sharp et al, 2000), and in studying the culture of agile methods in software development (Robinson & Sharp, 2003). Using such techniques has contributed to our understanding of software engineering and how it is practiced. We intend to continue this work, and are currently focusing on the use of metaphor as a complementary analysis tool.

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REFERENCES

BS5750 (1987) Parts 1-3 Quality Systems, HMSO.


ISO8402 (1994) Quality Vocabulary,

ISO9000 (2000) Quality Management,


