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2009

Why do people buy virtual items in virtual worlds? an empirical test of a conceptual model

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MEASUREMENTS, FEEDBACK AND EMPOWERMENT: CRITICAL SYSTEMS THINKING AS A BASIS FOR SOFTWARE PROCESS IMPROVEMENT

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Abstract

While organizations in software industry want to portray themselves as professional in terms of following standards and methods, they may also have needs for improvising and short-cutting when necessary. Such dilemmas of dual logics are sometimes internally resolved by evolving a false belief of what is done (practice) being in correspondence to what is said (standards), regardless of what an empirical investigation might show, something that can have poor business implications and also poor social implications. Particularly focusing on this latter point, the meta-methodology of total systems interventions (TSI) has been used for integrating critical systems theory with total quality management, improving social conditions in parallel with improving business processes. Although TSI is not designed for liberating organizations where nobody see themselves in need of liberation, the hypothesis of this paper is that it is possible to design quality management systems as "conflict machines", causing sufficient social tension for more or less automatically changing "fake quality" into "real quality". The hypothesis is investigated by applying design research in a Scandinavian public sector organization. The findings consist of statistical and interpretative evidence for the success of the approach, making a contribution to how TSI can be applied in the software industry.

Keywords: Software process improvement, total systems interventions, design research

1 INTRODUCTION

Selecting an effective strategy for designing software process improvement (SPI) systems can be a difficult problem, depending both on technical issues related to the complexity of production processes, software products, chosen set of SPI standards and practical engineering of the control system, and on social and cultural issues.

According to Brunsson et al (2000, p. 130), extensive research since the mid-1960s has shown that "there may be substantial differences between presentation and practice, between formal structures and actual operations, and between what people say and what they do. […] Actors have dual systems which are decoupled from each other; they may argue that they follow a standard while not doing so in practice. This is a phenomenon which standardizers seldom appear to notice, or at least seldom discuss seriously in public".

Indeed, in many of the classic references on total quality management (TQM) and software process improvement (SPI) (e.g. Crosby, 1979; Deming, 1986; Juran, 1993; Humphrey, 1989), the main issue is on issues like explaining the importance of aligning quality control with business strategies, measuring customer satisfaction, implementing the methods in a technically sound manner, and getting sufficient management commitment for making sure that the system will be developed and sustained. The issue of organizations pretending to follow standardized principles of TQM or SPI just to win contracts or attract customers, and how this influences culture, is seldom addressed.

Primarily focusing on the internal politics of organizations along the vertical axis of management and labour, Flood (1993) has developed an approach to TQM based on systems thinking and critical theory. The idea is that TQM should be understood in a holistic perspective and it should be used for improving social conditions along with business processes. The idea of implementing TQM in this way was developed as an application of a more general framework called Total Systems Intervention (TSI) (Flood & Jackson, 1991; Jackson, 2000). TSI has been a topic for discussions in academic journals for systemic research (e.g. Tsoukas, 1993; Flood, 1994), has been used as a framework for doing action research (Green, 1992; Flood, 2006), and it remains an interesting topic among both researchers and practitioners in the area of TQM (Taiwo, 2001; Beckford, 2002; 2009).

However, as Beckford (2002, p. 301) points out, "the process of [critical thinking in TSI] is, of course, only useful where all parties are willing to contribute to the process and to make adaptations based upon the findings". This does not present TSI as a promising approach when we deal with organizational dualism, implying primarily external motivation for implementing SPI. On the other hand, a well-known challenge in knowledge management systems design is that knowledge is political, meaning that changing the flow and distribution of knowledge may have consequences for explicitly and implicitly existing organizational power structures (Davenport & Prusak, 1998).

The hypothesis in this research is that (1) a political SPI system, exploiting political tensions induced by creation and distribution of knowledge, can be designed to fit with the ideas and framework of TSI, and (2) this type of political knowledge management approach can create a stable SPI process (improvement process) in an environment where there is otherwise little support for making SPI work.

In section two, a more detailed theoretical presentation of the revised TSI model will follow. This is followed by a section three concerned with the design of empirical research for exploring and evaluating the model in an empirical context of looking at how SPI is practiced among software engineers, managers and administrative staff in a Scandinavian public sector organization. The results of this investigation are reported in section four, pointing out aspects of the SPI project that were successful and aspects that failed. Finally, in section five, the empirical findings are used for evaluating the model, summarising the research in terms of pointing out how the political analysis leads to political guidelines all aimed at creating tension along the vertical and horizontal axes of the organization and making sure that the critical approach can be maintained.

2 PROCESS IMPROVEMENT BY SYSTEMS INTERVENTIONS

As SPI can be seen as TQM applied in the area of software engineering (Humphrey, 1989), generic quality management standards, such as the ISO 9000 standards and guidelines, can be used as framework for SPI. In the ISO 9000 series, there is a difference between control and improvement (Hoyle, 2006), that corresponds with what Argyris & Schön (1978) refer to as single loop learning and double loop learning. Quality control is the task of making sure that processes are carried out in compliance with standards and regulations (single loop learning). Quality improvement deals with challenging and improving such standards and regulations (double loop learning).

The diagram below illustrates the single loop learning of auditing a quality management system (QMS) used for defining a SPI system. The QMS contains all procedures and standards that describe how software engineering shall be carried out in a given organization, and this set of documents is used as a reference point $r(t)$ when doing audits $y(t)$. If there is a mismatch $e(t)$ between practice $y(t)$ and procedure $r(t)$, that should function as a point of action $u(t)$ for management.

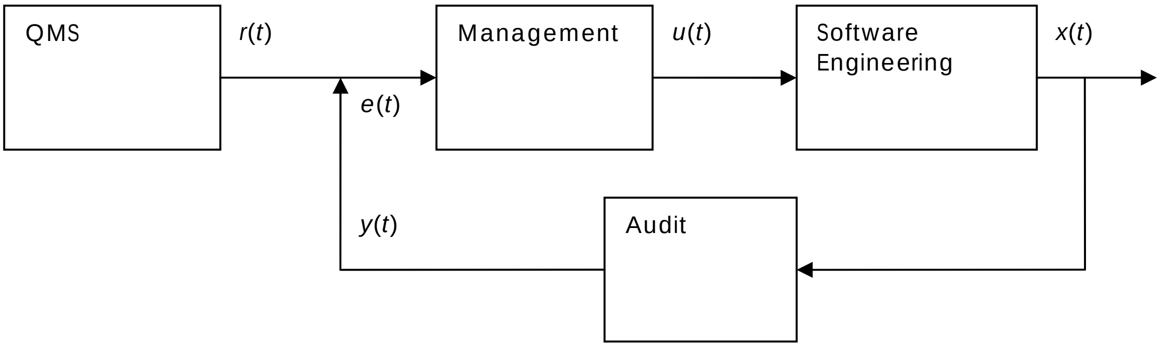

Figure 1. The basic configuration of a simple closed-loop control system (DiStefano et al, 1990, p. 16)

Mathematical theory of control systems started in electrical engineering, but has later been used both metaphorically and technically for studying both technical and social systems (Berlinski, 1976). In order to study the audit control system in figure 1 from a mathematical perspective, one would typically need a description of the relationship between $u(t)$ and $y(t)$ in terms of differential equations, and areas to be looked into would typically be observability, controllability and stability of the system (DiStefano et al, 1990).

2.1 Total Systems Intervention (TSI)

TSI evolved as a method for solving two problems; how to apply critical social theory in management problems based on a systems approach, and how to select the best systems methodology depending on the nature of the management problem to be solved (Jackson, 2000).

Doing TSI consists of going through three phases. First there is a phase labelled “creativity” that consists of using metaphors for trying to see to which extent various metaphors may give insights on problems and perspectives of the organizations (Morgan, 1980). Secondly, there is a phase labelled “choice” that deals with choosing an appropriate systems-based intervention methodology to suit particular characteristics found through metaphor analysis. As the makers of TSI experienced some difficulty in getting managers to understand Morgan’s way of linking metaphors and sociological paradigms, Jackson (2000) develop a simplified method called the “system of systems method”. Thirdly there is the phase of “implementation” which means that the conventional implementation strategies of Viable Systems Methodology (Beer, 1972), Soft Systems Methodology (SSM: Checkland, 1981), Critical System Heuristics (CSH: Ulrich, 1983), or whatever systems approach chosen is implemented, given that the implementation of a chosen methodology or mix of methodologies is employed according to the logic of TSI (Jackson, 2000, pp. 368-370).

Although practitioners working with TSI as an approach for implementing TQM reported successful results, theoretical criticism came from academia, questioning the use of metaphors for framing problems, the way metaphors linked with methodologies, whether TSI practitioners could be expected to have the enormous amount of systems theory knowledge that seems to be needed, whether each of the methodologies catalogued by TSI are as different as the framework assumes etc. (Jackson, 2000, pp. 371-374). As a consequence of such questions, TSI theory keeps developing (e.g. Flood, 2006).

What TSI still seems to lack in its analysis, however, is that the people responsible for designing organizational interventions may neither represent the workers nor the managers, but could be considered a separate group. In his comments on the early days of Operational Research (OR), Beer (1968) points out that there were ongoing tensions between managers and scientists. The scientists developed an understanding of the organizational problems from a mathematical point of view, although with little practical understanding. The managers had a practical understanding developed through experience, but little conceptual understanding in terms of mathematical models. This resulted in mutual distrust.

Rather than trying to provoke labour and management through the kind of critical questions suggested by CSH, for an organization that is only pretending to be committed to SPI, it is an underlying assumption in the hypothesis stated in this paper that it may be better to design the SPI system as a kind of "conflict machine", a system that is not primarily designed for making people think less in order to work more efficiently but rather as system that contributes to the production and distribution of knowledge in ways that are likely to challenge current power structures. The idea is to build tension along the management/scientist and labour/scientist axes and use debate that results from this for making the organization focus on the management/labour axis.

In 1996, Flood and Romm redesigning TSI in the language of triple loop learning. Figure 2 illustrates the principle of how the nested loops are represented with different types of logic. The innermost loop of the system tries to answer the question of how to improve efficiency, how to reduce error rates, how to increate customer satisfaction etc. If a SPI problem is formulated in a clear and well-defined way, there is a large body of literature from OR that could and should be used. However, if the problem is neither clear nor well-defined, there is a body of literature on Problem Structuring Methods (PSM: e.g. Rosenhead & Mingers, 2001) that include various methods for organizations to reach mutual understanding of problems. SSM is one of the most used methodologies of this category. The aim of PSM is to address the question of what the problem is. Finally, there is a third loop that aims as questioning why are given problems focused in the first place. Whose interest are people serving by solving the given set of problems? Who is gaining power? Who is loosing power?

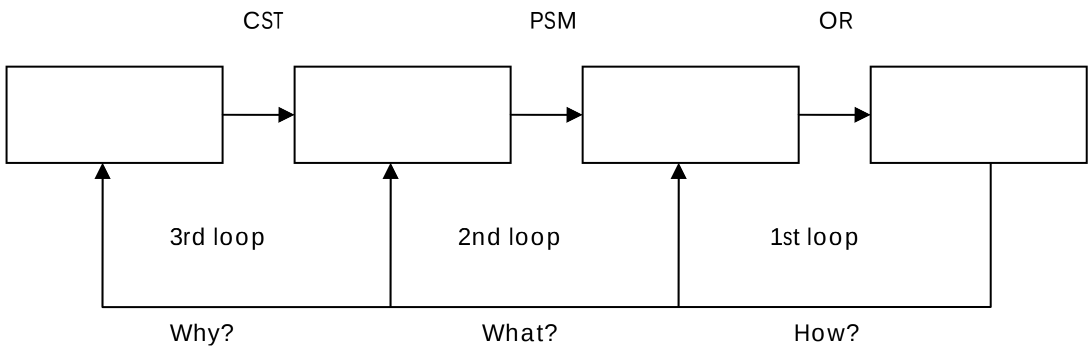

Figure 2. Triple loop learning as a way of describing TSI (Flood & Romm, 1996)

The control loop in figure 1 gives a more detailed description of the first loop in figure 2, suggesting mathematical notation and logic that fits with the rationality of OR. The single loop learning aspect of quality management can be a highly difficult problem from a technical point of view, but from a social point of view it is banal in the way that it simply consists of measuring whatever people are doing against the organizational standards of how it should be done.

Second loop learning in TQM is socially more challenging, as this loop consists of getting people in authority to interpret what is going on, try to make sense out of these interpretations and then choose targets for technical investigation and improvement. As Checkland (1981) argues, problem structuring methods such as SSM contain elements of critical thinking in the way that they challenge the views encoded in the single loop learning. Perhaps the problem being solved by the current OR loop is not the right problem to solve? An SSM analysis can bring in the perspectives of different people in the organization, producing a collective understanding of the organization and business, and cause radical changes in the understanding of what should being studied and improved.

For a SPI system to comply with the ISO 9001:2000 standard, the system must have elements of double loop learning. Not only do the ISO 9001 clauses require that process should fit with procedure, but procedures and all aspects of the QMS are to be audited and challenged on a regular basis (e.g. ISO 9001 clause no. 4.1; see: Hoyle, 2006). But, as argued by Brunsson et al (2000), the fact that an organization is required to practice double loop learning does not necessarily mean that it does, even if they are certified against ISO 9001 and being regularly checked.

The third loop in figure 2 is something that does not read naturally as a part of ISO 9001:2000, and something one would not expect to find in management consultant literature (Legge, 2002). From a business point of view, the aim of the organization may be issues like making a profit, or delivering services at high quality with low cost. On the other hand, there may be other agendas. The purpose of the third loop is to identify such agendas, help people to discover that they may be imprisoned by agendas they don't know, don't understand or may be unhealthy, and then to help in the process of liberation (Critical Systems Thinking, CST: Flood and Jackson, 1991), the socially critical aspect of TSI.

2.2 Adding the idea of a "SPI conflict machine" to TSI theory

As observed by Bénézech et al. (2001), the fact that the ISO 9001:2000 model can be interpreted as a double loop learning model means that a management system (or a SPI system) compliant with ISO 9001:2000 can be seen as a knowledge management system.

Although not explicitly stated by Flood (1993), one way of interpreting his use of critical theory as a foundation for TQM could be to say that quality management systems are not tools for managers to exercise command and control (e.g. Braverman, 1974), but they are rather tools for workers to gain knowledge and power over their own work situation, become experts and be able to challenge oppressive power structures.

In order to give people freedom, it is necessary that knowledge becomes visible and available. It is necessary that the implementation of TQM follows a strategy that is based on how knowledge about quality of processes and products affects the power structures of the organization. As pointed out by Davenport and Prusak (1998, p. 177), one of the main challenges in the implementation of knowledge management systems is that current power structures may be based on keeping people unaware, only letting an inner circle of people have knowledge that matters.

Reyniers and Tapiero (1995) discuss the design of contracts and the control of quality in a conflictual environment through the use of game theory. They model the situation between the supplier and producer as players in a nonzero-sum game, where the supplier can control the effort invested in the delivery of quality and the producer may or may not inspect incoming materials. In their paper, they state (p. 373) that the traditional approach to statistical quality control does not recognize that quality management often takes place in a conflictual environment.

The game design suggested in this paper, in order to make SPI work as a "conflict machine", is to regard the QMS as the rules of the game, use quality indexes (measurements of compliance with QMS standards) as payoff functions (“score”), turn the game from into a “perfect information game” (like chess, unlike the “imperfect information game” of bridge) by distributing the scores vertically and horizontally across the organization, aligning knowledge distribution strategies with power strategies as they may be identified through experience and analysis.

The most important design aspect of this SPI game design, however, is to make sure that the game is kept alive, in other words make sure that it does not challenge those who are capable of destroying the SPI system (“the owners of the system”; Checkland, 1981, p. 318).

3 METHODOLOGY

In order to investigate the effect of the revised version of TSI, the TSI method has been implemented and tested in an organizational setting, and a design research framework has been implemented (Simon, 1996; Hevner et al., 2004; Iivari, 2007). The design research approach is illustrated in figure 3, where the emphasis is on showing how the engineering cycle and the research cycle run in parallel through iterations of four stages, the engineering cycle applying theory while the research cycle aims at contributing theory. The ellipse marked “model” in the middle of the figure corresponds with the models discussed in the context of the theory in section 2 above with section 2.2 containing specifications for the design/artefact to be evaluated in the context of a TSI implementation.

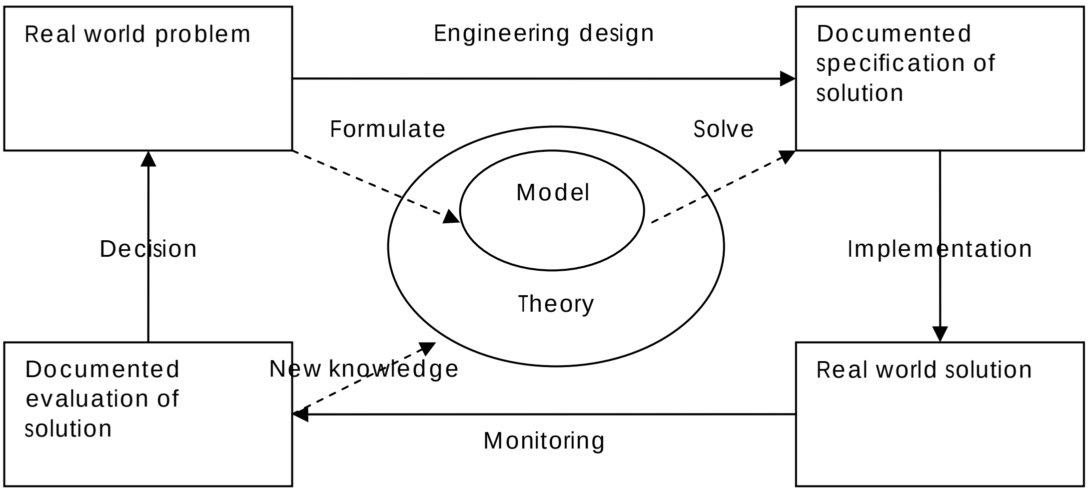

Figure 3. Design science in the context of the engineering design cycle (based on: Krick, 1969)

In practical terms, the way the engineering cycle is used as a framework for research is by using the assumption of a successful design and statistically stable design process as hypothesis, considering the design process as an experiment, and look at the design evaluation as a test of hypothesis. This idea was originally formulated by Shewhart (1939) as a way of thinking about quality control in the field of mass production as a framework for scientific investigations, where he suggests the use of statistical process control (SPC) as a way of testing the hypothesis that the design process is statistically stable (“assignable causes have been eliminated”; Shewhart, 1939, p. 150).

As the experiment is based on a short number of life cycle iterations, the X-MR chart will be used as SPC-design (Clark, 1999, pp. 86-90). In addition, as there are controversies among statisticians as to how SPC links with statistical hypothesis testing (e.g. Woodall, 2000), the testing of whether the SPI process is stable or not will be done by visual judgements (Interocular Traumatic Test, ITT) as suggested by Roberts and Sergesketter (1993, p. 64).

If the test should indicate that the SPI process is perfectly stable during TSI, this should indicate that similar designs should be carried out under other conditions, such as other units within the same organization or, preferably, other organizations. Otherwise, if the test should indicate problems, exploratory research needs to be carried out.

3.1 Population, research procedures, data collection and analysis

The setting for investigating the changed version of TSI is a software engineering unit within the IT department of a Scandinavian public sector organization. The unit to be discussed consisted of about 20 people, more or less equally distributed between males and females. The average age was about 40. Half of the people were systems designers who were also responsible for testing the system on large scale, while the other half were programmers that implemented the design in COBOL software and did detailed tests. The system followed an annual life cycle model, and all people were involved in writing and updating system documentation.

The initial version of the system was implemented in 1998, and the first few years consisted of making the solution fit with the original systems requirements. During the time of investigation, the system had reached a level of maturity where the life cycle work mostly consisted of making adjustments and improvements as requested by the ministry.

Although the TSI implementation was carried out through annual cycles between 2003 and 2005, aligned with the lifecycle model, earlier project documentation was also used. Three evaluation reports were produced during the TSI experiment, as decision support for management at the time of the annual life cycle when the system went into production. The reports were written by the author of this paper, then functioning in the role of quality manager being assisted by quality coordinators for doing audits and tests. The final analysis has been conducted after the TSI projected was completed, depending to a certain degree on retrospective reflection.

4 CASE STUDY

4.1 Evolution of the SPI system from a technical perspective

As a part of the design research approach, the tools for evaluating the design evolved as a part of the evolution of the software process improvement (SPI) system. In the context of this narrative, the SPI system consisted of the strategies, policies and standards that made up to documented part of the quality management system (QMS) and the QMS practices that were carried out in terms of checking whether the documented system was being followed, recording problems, and taking corrective and preventive action.

Prior to taking contact with the unit in question, some interviews were first carried out with IT top management and representatives of the internal audit. In both these cases, it was pointed out that the QMS for this particular unit was one of the better systems of the organization. People were following the rules, as they should, and there was organizational learning in terms of continuous improvement.

Reading the reports from internal audit and generating a general overview of the documented part of the QMS, it quickly became obvious that there were no independent quality audits, at least not in the way required by the general QMS. Perhaps the QMS worked perfectly within the unit, people following standards as they should, but there was no way of knowing this without establishing a practice of doing quality audits.

A quality audit system was easy to implement as the procedure V10 for doing audits was written and just waiting for being put into use. Separate audits should be done along the software development life cycle, including the phases (1) threat and risk assessment, (2) quality planning, (3) requirements analysis, (4) analysis, (5) implementation, and (6) test. As a final checkpoint on procedure V10, the audits should be summarized and presented to management as input for the acceptance procedure N7.

As there were detailed standards for how to document and carry out work within each of the phases above, it was easy to develop simple checklists that was then used for ticking off and producing quality indexes for measuring compliance on a scale from 0 to 100 percent, defining $e(t)$ in figure 1.

The diagrams in figure 4 show the final results of plotting the average of all quality indexes year by year. Indexes for the years 2000 to 2002 were constructed by performing quality control of old documents and old software, while the more recent indexes were computed along with the design process and used as immediate feedback. Control limits for X-MR are based on values 2001-2003.

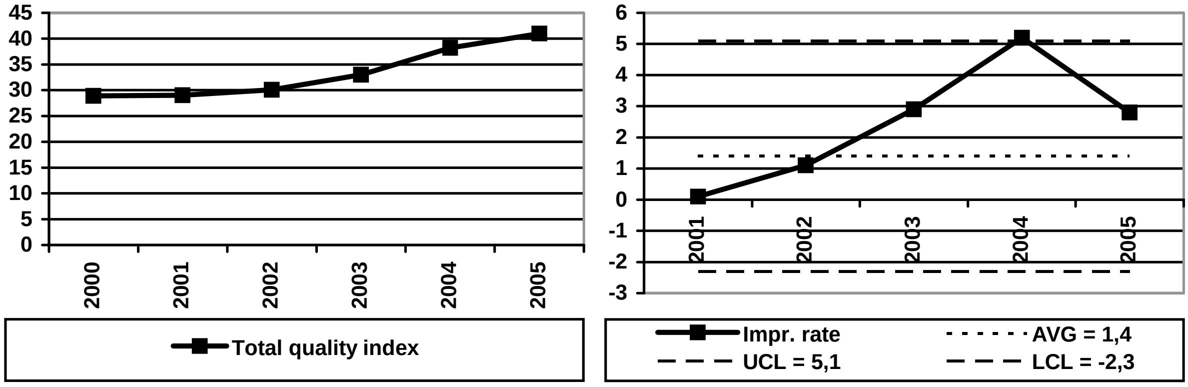

Figure 4. Total quality index and improvement rate (annual increase in total quality index)

As the X-MR diagram on the right hand side in figure 4 goes slightly above upper bounds in 2004, the null hypothesis of instability due to assignable causes cannot be rejected. The assignable cause for the anomaly is that the QMS consists of procedures and practice, and much of the practice was carried out by the quality department through their SPI design research rather than be the people in the unit themselves, indicating that increase in improvement rates may be a direct cause of the TSI approach.

Using a t-test with four degrees of freedom for comparing improvement rates before and during TSI made it possible to reject the null hypothesis of no difference in sample average at a significance level of 0.022. Recalculating control parameters for separating the process prior to intervention and during intervention, the average improvement rates would first be 0.6 before TSI and 3.6 during TSI. A SPC design based on X-MR only for the TSI period showed no indication of instability.

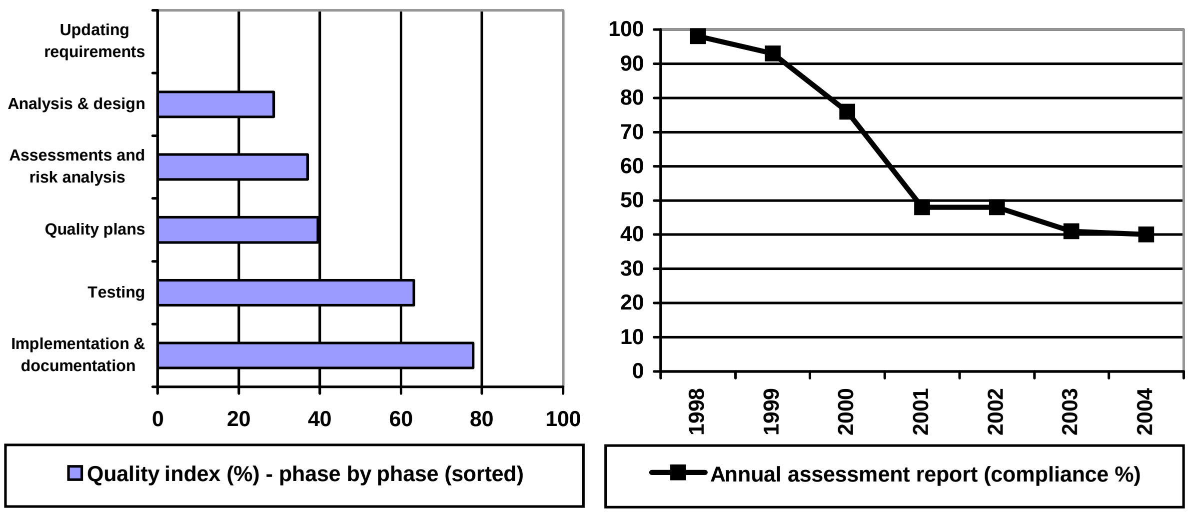

Figure 5. Total quality index and improvement rate (annual increase in total quality index)

When decomposing the total quality index into what was measured (the final year) for each of the six phases of the software cycle, the left hand side of figure 5 shows how the compliance between different phases differ. The right hand side of the figure shows the development of the column marked “assessment and risk analysis” on the left hand side of the figure, showing how the practice in this part of the life cycle got less and less compliant with the standard. Another indicator systematically evolving in the wrong direction (not included in the diagrams here) was a process capability indicator for measuring the ability of the production indicator to be within required limits.

4.2 Evolution of the SPI system from a social perspective

During the interview with the IT top manager prior to investigating this particular SPI system, the quality manager (author) was specifically being told to think about the organization and the systems development processes through the metaphor of a machine. The IT manager made some drawings in the air, indicating that he was thinking in terms of a hydraulic machine pumping information through the organization and out to the users and owners (ministry).

The systems approach used for structuring the problem of investigating the SPI was partly based on SSM-like principles like discussing with various people while drawing “rich pictures” in order to figure out how they differed in their understanding of the system. When doing audits of software engineering practice against the software engineering standards, this feedback was useful for understanding the gaps while not preventing gaps from being documented.

This approach, mixing conversations with measurements, became the implementation method that was followed consistently during the three years of the experiment.

<u>First year:</u> Reporting the findings upwards in the system caused emotional stir. People felt they were doing as best as they could, performing and documenting much better than what was required by the standards, and felt humiliated and demotivated by quality audits giving them scores in terms of numbers (“quality index”) and so on. They wrote a letter to the general director (head of the larger organization) and complained about the situation. The quality manager never got a copy of the letter, but was told by the IT manager that there were some misunderstandings and that quality audits should continue as planned.

<u>Second year:</u> Based on previous year’s unfortunate circumstances, it was important to be gentle yet sufficiently specific in order to help the software unit to improve. However, as new versions of documents were audited, the same errors and lack of compliance with standards remained. Little improvement. The people said they did not have time to improve, just to do what was absolutely necessary. Besides, they felt quality audits focused too much on process and forgot about the product. They said they took pride in producing products of high quality, and methods (means) for achieving such excellent results were of less importance as long as the results were good.

<u>Third year:</u> Trying to respond seriously to what people were saying, the same audits from the previous year were repeated but now expanded in order to include product quality indicators. Using statistical analysis, the quality management people found that the main production indicator for the system was rapidly declining, as could be seen from updates of the annual Cpk capability index (Deming, 1994). When presenting this finding to the systems and software people, they said this had to be the result of socio-geographical dynamics, not a phenomenon they could control. When asked about whether it would be a good idea to improve the prediction algorithm that caused the problems, they said they had no time for dealing with such issues. It was too difficult. They had been told to follow a given formula, and it was not their task to analyse whether this formula was optimal or not.

In 2005, after the study was completed, the people in this particular unit took part in rewriting software engineering standards to be used for further SPI. When the software engineering standards were updated, many of the changes in the methods and standards were of a kind that would give higher score according to the quality audit system but would make the method it self significantly worse. For instance, the process of updating requirement documents was eliminated.

5 DISCUSSION AND CONCLUSION

The development of the SPI system followed the three stages of TSI. Creativity: The quality manager was explicitly told to think about the organization as a machine. Choice and implementation: According to Flood (1993, p. 81), typical systems methodologies fitting with the machine metaphor are the classical management frameworks described by Taylor and Fayol. In order to carry out the technical part of quality audits, this was done according to the professional guidelines of quality engineering, i.e. in a machine-like manner.

However, this rigid design proved useful in making people respond and reflect upon the standards they had defined for their own work. When presenting the results of audits, a “soft systems approach” was used, in order to figure out what people were thinking, how one could solve the situation together, asking people what they would do if they were responsible for doing quality audits etc.

Unlike Flood’s attempts to ask critical questions for making people reflect, the method of trying to force people to follow their own standards by first “measuring the facts” and then doing SSM-like discussion, worked well for creating debate. Particularly the way audits and quality reports were widely distributed made the QMS into a “conflict machine”.

5.1 The illusion of excellence as a mental prison

It is not too difficult to see how the organization was imprisoned in a belief of high quality and continuous improvement, while the measurement of practice against standard indicated low degree of compliance with internal quality standards and continuous spiralling in the wrong direction. Similar to the cases reported by Brunsson et al (2000), the organization had locked itself in a situation where there was no measurable feedback on whether they were doing the right thing or not, only good intensions, hard work, and occasional verbal feedback if production went well.

It did not improve matters that the internal audit had investigated the unit, been impressed by standards, written procedures and system documentation without going into depth when analysing how this was used. The result of this may have been twofold; firstly adding to the beliefs of the organizational unit that they were doing things as expected, and secondly enrolling the internal audit into the same “fake quality” belief system, as it would be easier to accept the happy belief that the unit was doing fine rather than to question the quality of their own audit methods.

Although not specifically mentioned in the case study, as it happened prior to the time when the TSI experiment was carried out, the national audit had done a similar overview audit to what the internal audit later did, also contributing to the general belief that everything was fine. In other words, it would almost come as a surprise if these people were not trapped in an illusion of excellence and internal bliss, like Adorno’s interpretation of Odysseus and the lotus eaters (Sherratt, 2000).

5.2 The liberation process

As explained in the story, the “fake quality” was easily revealed through quality audits as what people were saying did not fit the results of the audits. When confronted with the facts, the response was a mixture of surprise, irritation and what they described as “unfair game” of being measured and having the measurements distributed upwards and sideways in the organization. The crash between their self-perception of what they were doing and the measurements caused emotional outbursts and intense debate.

In other words, liberation through quality management was in this case a process of agony and frustration, and it remained a difficult process during all three years of the experiment. While there were no dramatic changes during the period of experimentation, there were signs of improvement in terms of discussion and awareness of quality management issues that seemed to have been more or less totally ignored after the QMS had been documented and made into "shelfware".

Although some of this liberation resulted in attempts to fight the quality department and attempts to change the software engineering standards for producing better score without resulting in higher quality, the main reason for applying critical theory as a foundation for SPI should not be to force people follow standards or force them do what the quality department wants them to do, but it should be to generate debate about standards and make people take responsibility for their own software engineering processes.

The fact that the software engineers got the methodology group to remove the maintenance of the requirements documents from the software engineering methodology (end of section 4.2), despite the fact that the organization was required to keep a ten year record of requirements, was an interesting example of how SPI can be a political game of accepting and distributing responsibility. Although a strategy like this would be helpful for improving the score for the software engineers, the overall impact on the organization would be a step backwards down the maturity ladder if assessments had been done through CMM or similar SPI models (Zahran, 1998).

5.3 Theoretical implications for the TSI model in software process improvement

Although the SPC diagram and statistical reasoning in section 4.1 do not contain sufficient data for making judgements that would convince a properly trained quality engineer, the results are consistent with the interpretative narrative.

The interpretative part of the study provide the key insights on what happened, although a rich case like this contains actors and actions responding and reacting in different ways. By thinking about SPI as knowledge management rather than control, the design idea of using (1) horizontal benchmarking, (2) vertical jump-reporting and (3) improvisation for preventing those in power to destroy the TSI implementation, made the SPI system work successfully as a "conflict machine".

Although three years was a rather short period for a case like this, and the fact that the design was particularly made to fit with the internal power struggles in a hierarchical public sector organization, the design idea (section 2.2) worked well, making a theoretical contribution on how TSI can be applied in the software industry.

The overall interpretation of the case study is that the use of critical thinking as a foundation for SPI was a fruitful idea that should lead to more empirical research.

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