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# Understanding and Changing Software Organisations: An Exploration of Four Perspectives on Software Process Improvement

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# Understanding and Changing Software Organisations:

## An Exploration of Four Perspectives on Software Process Improvement

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### Abstract

In this article we discuss four different perspectives on software process improvement, which are all based on quite different assumptions. The objective is to expand the views on software process improvement and contribute to a wider understanding of software process improvement. This might facilitate the application of software process improvement and assist in further spreading the approach. The different perspectives are expressed through four different metaphors for the work of process agents. These describe process agents as (1) technical experts, (2) facilitating participants, (3) political agents, and (4) individual therapists. We argue that the four perspectives do not preclude each other and that they can be applied to more or less effect to understand different process improvement situations. The advantages and disadvantages of each perspective for improvement work will be discussed and illustrated by examples from an ongoing software process improvement project.

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## 1. Introduction

Software process improvement deals with understanding and changing development practices in software producing organisations. A person who has the explicit role to understand and change a software organisation's software development processes is called a 'software process change agent', a 'software process improvement consultant' or, in short, a 'process consultant' or 'process agent'. Behind software process improvement theory and practice there lie a number of assumptions, both explicit and implicit, about the world in general, about software development in particular and about the knowledge about it that can be produced. These assumptions or perspectives indirectly guide the way process agents perform their work.

In the traditional software process improvement literature one perspective is predominant. However, in this article we will discuss four alternative perspectives on software process improvement that are all based on somewhat different assumptions. The objective of the article is to present these alternative perspectives in order to expand the views on software process improvement. By doing this we want to contribute to a wider understanding of software process improvement and to illustrate the complementary ways in which process agents could analyse and assess a software organisation when attempting to introduce change and improvement in the work processes of these organisations.

As it is our belief that theorising about software process improvement can benefit from research performed in the broad domain of organisational science and in particular from research on organisational change, we utilise a conceptual framework based on Burrell and Morgan's (1979) work on different perspectives in organisational analysis. This framework has been applied previously in the field of systems development by Hirschheim and Klein (1989). Their work concentrated on different ways of understanding the problem areas for which information systems and software are developed, focusing in particular on the organisation and the people using IT. They examine the different ways in which systems developers view organisations and apply different methods. However, Hirschheim and Klein do not address the ways in which process agents and software developers view and understand software organizations [1].

Here we apply Burrell & Morgan's framework (1979) to understand software process improvement focusing on the roles of process agents. We argue that process agents act according to different perspectives or logics. These can be expressed through four different metaphors: process agents as (1) technical experts, (2) facilitating participants, (3) political agents, or (4) individual therapists. It is argued that the four paradigms do not preclude each other and that they can be usefully applied in different situations of process improvement endeavours. The advantages and disadvantages of each perspective for improvement work will be discussed and illustrated by examples from an ongoing software process improvement project. This might contribute to a more successful application of software process improvement and a further spreading of the approach.

The article is structured as follows. The next section presents the background and methods for the research. Following this the relation between Burrell & Morgan's (1979) framework and software process improvement is clarified. This provides the basis for a detailed presentation of the four perspectives. These are then compared and, based on this comparison, conclusions are drawn concerning the work of process agents and the performance implications of software process improvement projects.

## 2. Background and Research Methods

The results presented here are based on a software process improvement project in a small Danish software company. This company had 60 employees and was developing one main product, namely an intelligent WEB portal. The authors were actively involved in assisting the organisation through this process improvement project over a period of over 2 years. During this time as process agents they performed a variety of different roles and activities. These included: observation and assessment of the organisation's current status analysis and interpretation of the problems and actual assessment results elaboration of procedures and standards introduction of appropriate procedures, techniques and tools education of personal participation in working group supervision, tutoring, mentoring, and coaching. Given that the authors participated actively in the entire process and intervened and changed the organisation's practices,

the work can be characterised as a longitudinal study based on the principles of Action Research (cf. Argyris & Schön, 1991).

From the outset the improvement work was oriented to a large extent towards the Capability Maturity Model (CMM - Humphrey, 1989). The idea of this model is that all software organisations can be categorised according to one of five levels of maturity. To improve, they should pass sequentially through all stages of maturity using the 'IDEAL' model (McFeeley, 1996). The IDEAL model describes the phases, necessary activities and resources which are needed to implement and manage software process improvement in an organisation. The model (I for initialisation, D for diagnosis, E for establishing, A for acting and L for leveraging) is cyclic to allow for continuous improvement. This model was successfully utilised in the project that forms the empirical basis of this research (Kautz et al, 2000).

At the end of the first improvement cycle, a process evaluation was produced. This concluded that there was considerable deviation in this organisation from the models of process improvement prescribed in much of the literature. The models and methods prescribed had, then, to be adjusted in a number of ways in order to be made applicable to this organisation. Among other issues, as process agents we were confronted with the actual problems experienced by staff - namely the lack of appropriate meeting guidelines and structures - and other digressions from the IDEAL and the CMM models. That said, we also found elements of these models useful to frame our work.

This experience provided the stimulus for this paper. In particular it indicated a need to understand the differences between the theoretical models and methods as proposed in the conventional literature and our own experience and approach. Thus the remainder of this paper attempts to explain different perspectives on process improvement and to provide a framework which can be used when considering the applicability of different approaches in future process improvement endeavours. The main emphasis is on showing how various perspectives can be used constructively within process improvement projects, rather than on a critique of the dominant model per se. The purpose is to show how the process agent, by adopting different perspectives, can identify the different areas of improvement necessary for successful software process improvement. Each perspective thus provides a different focus on software process improvement and the perspectives complement each other. The four perspectives are introduced next, based on a conceptual analysis of the literature, and are illustrated by examples from the software process improvement project in the small Danish software enterprise in which the authors participated.

## 3. Scientific Paradigms and Software Process Improvement

Burrell & Morgan (1979) use the concept of 'paradigm' in their work. This suggests that human beings see the world in particular ways, or through particular lenses, and are not necessarily aware of, or conscious about, their own predetermined world views. Process agents are no exception. Kuhn (1962), in his analysis of scientific work, defines such unquestioned, scientific assumptions within a discipline as 'paradigms'. As long as one paradigm dominates, scientists work within the domains of 'normal science' - they try to make facts fit the theory. However, if too many anomalies are found, a paradigm 'shift', or change, takes place. Kuhn (1962) puts forward the notion that in science paradigms take over from and replace each other. However, in the humanities different paradigms can co-exist. Burrell & Morgan (1979) argue from a social science perspective and suggest that there are four competing paradigms to understand organisations that exist in parallel.

The four paradigms are shown in Figure 1. These differ according to two underlying dimensions. The first dimension is defined in terms of different philosophical approaches to sciences, roughly speaking by distinguishing between objective approaches (with characteristics like realism, positivism, determinism, and the belief in quantitative methods and universal laws) and subjective approaches (characterised by no belief in the existence of a social world external to the individual, anti-positivism, voluntarism, ideographic methods and personal understanding and enlightenment). The second dimension is determined in terms of different views on society, roughly speaking by distinguishing between explanations of society as based on social order, consensus, social integration, satisfaction of personal needs (this being called a sociology of regulation) and explanations of society as concerning structural conflicts, dominance and power, contradictions and deprivation (a sociology of radical change).

Taken together the two dimensions generate four

paradigms: functionalism, interpretavism, radical structuralism, and radical humanism. To be within one paradigm means that one sees the world in a particular way, which is fundamentally different from each of the other paradigms. In other words, these are fundamentally different ways of analysing, understanding and handling social phenomena. One cannot work within more than one paradigm at a given moment in time. As Burrell & Morgan (1979) express it "they are alternatives in the sense that one can operate in different paradigms sequentially over time, but mutually exclusive, in the sense that one cannot operate in more than one paradigm at any given point in time, since in accepting the assumptions of one, we defy the assumptions of all the other". However, the distinction among the paradigms is useful as it provides "a tool for establishing where you are, where you have been and where it is possible to go in the future". This is the foundation for the following arguments in this paper since it is these paradigms which allow process agents to look in different ways at organisations. They provide them with different ways for understanding and changing software organisations' development processes.

<table>
<tr><td></td><td colspan="2">Sociology of regulation</td><td></td></tr>
<tr><td rowspan="2">Objective</td><td>functionalism<br>technical expert</td><td>Interpretavism<br>facilitating participant</td><td rowspan="2">Subjective</td></tr>
<tr><td>radical structuralism<br>political agent</td><td>radical humanism<br>individual therapist</td></tr>
<tr><td></td><td colspan="2">Sociology of radical change</td><td></td></tr>
</table>

Figure 1: Burrell and Morgan's (1979) Sociological Paradigms.

Applying these four paradigms to software process improvement leads to four stereotype descriptions of process agents and their work:

As a technical expert, the process agent operates in a functionalist paradigm. He [2] believes that he can fully understand the problem area with the help of a formal assessment based on a predefined best-practice based model. Empirical data is objective and the truth is shared. Every qualified researcher can find it provided, of course, they use the correct scientific method. A functionalist shows statistical relations between phenomena [3]. His assumption is that with rational and structured action, he can get the improvements implemented in a fast and efficient way. He also believes that the organisation can be completely controlled by introducing procedures and standards to perform work processes. As a technical expert he has 'unique' knowledge about how the process should be best carried out and this knowledge has to be transferred to the organisation.

As a facilitating participant adopting an interpretative perspective, the process agent bases his work on the assumption that the world is socially constructed. He tries to understand the processes, even if he believes that several different perceptions of reality exist and that complete understanding is impossible. He observes social processes to learn more about the participants' subjective opinions and the ways in which these are constructed. Facts are not static, but based on changing social definitions - the parts of the phenomenon can only be understood in relation to the context as a whole and vice versa. The ideal is to understand people in situations, but not to explain and predict. As intersubjectivity creates reality, it is impossible to relate to the future. The process agent accepts that there is no one complete solution for all organisations. Problems, solutions, and approaches can not, therefore, be determined by the process agent alone. The focus here, then, is more on the process agent as performing a consulting and facilitating role where the members of the organisation discover for themselves the improvements and solutions which are relevant for them in their particular situation.

The process agent as political agent in the radical structuralist paradigm will try to recognise and resolve structural conflicts among different stakeholder groups in the organisation, but he actively sides with one group. The process agent strives for change through influencing the tensions and contradictions among organisational members. Understanding is related to objective, not personal, value carried in facts concerning structural relations and relations of dominance. A political agent supporting one group uses dialectics - the definition, analysis, and debate of thesis and antithesis - to elucidate the situation under investigation and brings them into play to persuade or

convince the opposite party. The process agent believes in radical change. At the extreme he sees conflict and chaos as 'healthy' - i.e. as something that contributes to continuous improvement. Dialectical arguments provide possibilities for breaking down deep-seated structural conflicts and states of dominance.

As an individual therapist in the radical humanist paradigm, the process agent assumes that reality is socially constructed. It is a product of the individual subject who can be influenced by psychological and social processes and focuses on how human beings can be encouraged to leave their 'psychological prison'. Understanding is produced by investigating how individuals create their psychic worlds and how this delimits their world. The process agent works with the different individual subjects' attitudes and opinions, because he recognises that the world(s) are created by the individual(s). It is not essential in this paradigm that the developers have a shared understanding of the process, but the strength lies in the different thinking among members of staff who have different views on the process. Process improvement happens through 'treatment' of the personal limitations that hinder the ability of the human to unfold and think in different ways and thus also limit the organisation's success.

## 4. The Four Paradigms

The basic idea of all software process improvement is that there is a relation between the quality of the product and the organisation's capability to perform the software process - the quality of the process. In the four paradigms different approaches are taken to improve this process. These will now be presented in more detail using examples from the improvement project in which we participated.

### 4.1 The functionalist perspective: the process agent as technical expert

In the functionalist paradigm, process improvement is based on prescriptive reference models, such as the CMM, representing a fictional optimal state and defining the so-called key process areas that constitute this state. The overall objective of the improvement process is to ground an organisation's work processes upon a rational approach. The assumption is that, through standardisation based upon a reference model, a common foundation from which to estimate, plan, control and perform development can be achieved. The objective of working with process improvement is profit maximisation through better quality and productivity.

According to this paradigm management and process agents are the main actors. They define the goals and objectives for the improvement endeavour. A process group has the leading role in the implementation of the improvement. The process agent is, in this situation, the professional, technical and impartial expert who identifies an organisation's strengths, weaknesses, maturity level and profile through an objective evaluation of the current situation in relation to the chosen reference model. Through this evaluation, the process agent develops and implements an improvement plan. Professional staff have to be at the assessors' disposal to provide the data that is required.

To understand the problem area the organisation's current practices are assessed in comparison to the reference model's prescriptions. As the reference model predefines which processes should be performed, the actual problems as experienced by staff are only of secondary interest, if considered at all. Questionnaires and individual interviews are the preferred means of investigation. To achieve objectivity, the answers to the questions and the observations made have to be based (for example in the CMM) on at least two different independent sources or have to come from at least two different data collection sessions.

To change the problem area process agents work with the predefined key process areas, look systematically at the organisation's procedures, standards and policies and bring them into agreement with the reference model. Through standardisation a rational work process determining all development processes is described. In this way there is no doubt about how the process should be conducted. By following the descriptions of all key practices as presented in the reference model, procedures are defined for the execution of key processes. The questions from the questionnaire can be used as checkpoints for the elements of the reference model. As the processes defined represent 'best practice', following them will lead to the development of high quality software and satisfactory working conditions.

One example in our case of the functionalistic paradigm was management's request for one character to describe the organisation' capability with respect to the CMM. The process agents delivered this character by using the methodology's approach for

the determination of characters - mainly by counting the number of 'yes' and 'no' answers given by the project leaders to questions on a survey instrument concerning CMM level 2 (Kautz et al., 2000). A second example was the introduction of configuration management routines. The assessment had shown that no configuration management routines were in place in the organisation, nor were the employees familiar with the concept. Therefore the process group worked with this key process area on its own and without further consultation of the staff. Based on a literature review and available routines used in similar organisations (Kautz, 1998), the process agents, as technical experts, developed rules and support tools in an authoritarian manner and implemented these in the organisation when first versions of the organisation's product had to be distinguished. Although not involved in the development process, the routines were accepted by the staff and have been utilised by them since. Finally, in the same way as technical experts the process agents developed a set of templates for requirements specifications.

The functionalistic approach has a number of disadvantages. First, it does not really take into account what staff consider to be problematic and actual problems. Second, the classification of maturity level, although a useful indication, provides only a limited insight in the situation. Finally, even proponents of the functionalistic approach (e.g. Zahran, 1998) acknowledge that assessments based on the functionalistic approach also have a large subjective element. This brings us to the next perspective.

## 4.2 The interpretavist perspective: the process agent as facilitating participant

Within this paradigm process improvement is based on the belief that software organisations are subjectively understood, based on human interpretation. Staff members from different organisational levels have different perceptions of what the problems are and how to solve them and, as every organisation is unique, there is no single identifiable best practice.

The main objective here is not to benchmark but, rather, to identify and develop a shared understanding of problem areas and improvements. Different objectives are recognised and acknowledged as legitimate. The process agent's task is to combine these and to try to satisfy all stakeholder groups. The process agent's objective is to achieve a form of agreement about what the problems are and how they can be solved. This is achieved through involvement and participation. Thus, according to this approach, all members of staff are main actors. Process agents consider all the different opinions with the aim of reaching consensus in the organisation through discussion and negotiation. This might take the form of compromise or persuasion where one group is able to convince another that it is right.

This approach builds from the belief that organisations can not be understood and appreciated solely on the basis of structured questionnaires and interviews which aim, for example, to classify the organisation according to a maturity model and from there derive improvement proposals. The process agent, in this case, is convinced that not all strengths and weaknesses can be identified based on a pre-fixed, predefined questionnaire or interview schedule. It might be necessary to define questions about non-technical aspects such as organisational and cultural issues. For example, the Bootstrap methodology (Kuvaja et al., 1994), although also based on a predefined questionnaire, is an attempt in this direction. In this case the assessment methodology is used to start a dialogue with and among members of the organisation. The purpose is to comprehend and to look at problems from different angles. Therefore a significant part of the assessment is always a group interview or an in-depth discussion in which the process agents act as facilitators and participants. They promote debates and inform understandings with their observations. They support the organisational members who themselves identify the problem areas as they perceive them and not as they are determined by a reference model. Improvement proposals are developed by the staff through active participation in the discussions with the process agents. To achieve change the process agents support the establishment of working groups and act as participants and facilitators but not as technical experts while solutions, procedures and standards are defined by the working groups themselves.

There are several examples for this paradigm in our case. At least two different objectives were identified and accepted, namely top management's request for a maturity level character and profile and the project leaders' need for better project and resource planning routines. Both demands were jointly satisfied. An example of shared identification of problems and solutions was the recognition of lack

of discipline in meetings, which was mentioned in all assessment discussions. For example, many meetings were held, but the resulting information was not communicated to all the relevant people. There was a lack of structure and documentation rules. During the interviews the employees made significant proposals for improvement. A working group consisting of interested staff members was established and the process agents scheduled a date for their first group meeting and appointed one person as responsible for the preparation of that meeting. They also participated in that meeting. Then, the group needed two more sessions to develop a solution. They then informed the other staff members who accepted the proposals they had prepared. No further action for the uptake of the routines had to be taken as all employees had been involved in the definition process. Finally, after the templates for requirements specification had been in use for some time, different needs for the description of requirements emerged. A new working group, in which the process agents again participated only at the outset, was established. This group developed a second set of templates, which were subsequently utilised by all other staff members successfully.

A problem with the interpretavist view is that when assessments are only based on open discussions and subjective perceptions, problem areas as described in the improvement models might not be recognised at all. This brings us to the next perspective.

### 4.3 The radical structuralist perspective: the process agent as political agent

In this paradigm, process improvement is based on an understanding that the world objectively exists external to individual cognition and independent of human consciousness and interpretation. Reality in software organisations consists of tangible and observable tensions, contradictions, disagreements, and paradoxes between people concerning existing development practices and improvement proposals. These tensions exist between many stakeholder groups: between top management and project management, between top management and development staff, project management and development staff, between management and process agents, and process agents and developers, and one group might exercise power upon the other.

As political agents process agents look for, identify and resolve conflicts between different stakeholder groups. However, they do so by choosing a side rather than necessarily aiming at a compromise. The objective is to resolve contradictions.

Understanding and change are interrelated. The process agents use dialectical analysis, identifying or developing a thesis and an antithesis, and building a synthesis to clarify a problem and propose a solution. They are not fundamentally interested in the different perspectives different stakeholders have on the world. For them, these are expressions of conflict and dialectic contradictions between different interest groups. Their aim is to try and find regularities and rules to apply to the dialectical contradictions.

In the belief that people are shaped by external factors, the process agents believe that by influencing the contradictory factors people's actions can be changed. However, they are aware that sometimes it is not enough to simply change people's perceptions of a situation. Sometimes, for example, real change in the distribution of resources is needed to improve the situation.

Through the process of shaping dialectical tensions the process agents trigger change. As a starting point for change they primarily use debates. In discussions for example, they often attempt to negate the prevailing position and by so doing in a dialectical manner they try to elucidate truth, - that is the truth of the party they have chosen to support. Thus, they might engage in confrontation with those who have power, although this is not necessarily inevitably. Members of staff are thus both objects when subject to influence and subjects when involved actively in the improvement process.

In contrast to a functionalist, who is sure what to do and which processes to change, a political process agent acknowledges that dialectical tensions are continuously changing and that it is therefore impossible to precisely predict organisational development. Therefore they do not attempt to precisely design the work processes for the developers, but instead use this uncertainty as an opportunity to experiment with alternative possible solutions.

We can illustrate the political perspective in our case using two examples: After two separate discussions and assessment sessions with management and project leaders we identified two different perspectives on project planning. Management saw a project plan as a definitive contract between themselves and the developers to be drawn up at the beginning of a project - the developers committing themselves to optimal

performance within a given time frame. Management naturally wanted to minimise this time frame. The project leaders however, saw project plans as a device to be used during the whole development process. It was to be used to optimally structure activities and to plan, re-plan and distribute resources in order to avoid bottlenecks throughout the project. For project leaders therefore, it was not essential to produce an entirely 'perfect' plan at the start of the project. What needed to be ensured was that it was updated appropriately during the process. As process agents we had to clarify the project plans' significance for the course of a project. We convinced management that the overall scope and associated tasks within a project could be defined without necessarily determining and subsequently sticking to detail planning from the outset. Although this was understandably difficult for them, management recognised that such detailed planning was not possible for innovative projects. In this case then, we supported the project leaders in their perception of project plans as tools to be used throughout the project rather than as a binding contract which up front specified the course of the project in its entirety.

The introduction of a requirements specification also had a political dimension that was understood with the help of dialectics. After having previously ignored requirement specifications, management had subsequently emphasised the importance of them. We had to moderate their expectations and requested time, as staff did not see the necessity for managing requirements and developing requirements specifications nor did they know how to develop them. We therefore had to convince staff that because of permanent time pressure they actually did not have sufficient time to not manage their requirements. We thus became the negation of their perception of what good development practice was. As a synthesis in a timely process we developed and demonstrated a way to handle requirements through the use of simple templates. The templates themselves were functionalistic (see sec. 4.1) and were subsequently re-developed co-operatively (see sec. 4.2).

It is a significant challenge for process agents to manage all the contradictions at all levels within an organisation. This brings us to the last perspective on process agents, where the focus is upon individual staff members.

### 4.4 The radical humanist perspective: the process agent as individual therapist

This perspective assumes that process improvement is grounded in an understanding that individual staff members are the starting point for any improvement in an organisation. The humanist paradigm deals therefore with learning about individual's strengths and weaknesses, their background, their knowledge, and their limitations and with breaking down the barriers that hinder them as a fundamental prerequisite that will improve their capabilities and thus increase their effort.

As therapists, process agents move beyond being aware of different interest groups with different views - acknowledging that there is no world external to the individual, but that there are different individual views of the world, which are based on individuals' different mental models of the world. Process agents therefore see conflict as subjectively created and not objectively existing. Conflicts delimit the developers' unfolding worldviews. When they are resolved and the developers are rid of these limitations, a reflection process can start which might result in improvements.

Improvement aims to develop emancipated, engaged, motivated, and innovative staff. Improvements can therefore be achieved through promoting personal development rather than through the use of standards and procedures. From this perspective, it is not essential that staff have a shared understanding of the process. In fact the strengths for the organisation lie in staff having naturally different perspectives on software development.

To understand the problem and to alter practice the process agents try to come close to the individual subject and to involve themselves in individuals' daily life. In so doing they try to understand how staff members create, modify and interpret the world they are a part of. During the formal assessments, and beyond, in informal conversations, process agents engage in a close dialogue with the individual in order to find out which barriers and conflicts hold them back from improving their own and others development processes. The process agents help the staff members not only to judge their existing situation, but also influence them to engage in a reflection and change process.

In our case, several examples - especially the introduction of requirements specifications can illustrate the perspective of process agents working with

individuals. Initially, a highly respected project leader was chosen as a champion for the whole improvement endeavour to eliminate a possible block by the development staff. Requirements specifications were not originally considered a necessary and valuable development task. Numerous individual sessions were needed to work on managers' individual subjective attitudes and to open the developers up to the idea of developing ways to document requirements using templates. However, even when doubts were assuaged, several staff members refused to sponsor or promote the introduction of these more formal routines. They wanted to avoid a confrontation - to be perceived as campaigners for change in a comparably egalitarian organisation with many informal work practices. The confirmation that the majority of staff actually wanted greater levels of formalisation eventually resolved this situation. In addition, the refinement and amendment of the specification templates was initiated based on knowledge about individual staff members and their influence on removing further obstacles. For this purpose a working group consisting of newly employed, greatly esteemed staff members was formed to work on the refinements. This approach led to the ready acceptance of the refined templates.

The requirements specification example also demonstrates that the radical humanist paradigm would be too ambitious and unrealistic if process agents attempted to deal with all individual staff members' subjective perceptions and attitudes. In addition, process agents have to behave in a similar fashion to a psychiatrist and this might be somewhat overwhelming when confronted with some limitations that do not stem directly from the organisations' work practices, but from the staff member's personal background.

The requirements specification example also begins to highlight the way in which different paradigms are intertwined. This will be illustrated in more detail in the next section.

## 4.5 Shifting Perspectives and Paradigms

In our project the different paradigms have been used in different situations and contexts. To take what from our perspective was the most appropriate action we initially unconsciously, but later, following the first evaluation, more consciously shifted from one paradigm to another under certain circumstances. In the course of our project, therefore all paradigms were utilised, the improvement of the requirements management and specification process as described in the preceding sections serves to illustrate this point.

In the following subsection we provide two more coherent examples to demonstrate when and why we shifted paradigms. The first deals with the introduction of another individual improvement action, namely the implementation of the key practice estimation as part of the CMM's level 2 key process area project planning. The second covers the first full improvement cycle of the project following the IDEAL model.

### 4.5.1 The Key Practice Estimation

The starting point for the introduction of estimations was the fact that during the initial assessment staff constantly mentioned that they were permanently under tremendous time pressure and that the only estimate for performing a task was a fixed deadline set by top management.

As a first step the process agents scheduled a meeting where they facilitated a discussion to bring the different points of view and opinions out into the open. In that meeting management argued that the estimates fitted well, while staff disagreed. However, management made public how they reached their estimates – fundamentally these were purely based on market pressures. For example, estimates would be driven by the need to present the firm's innovations at a trade fair before competitors did. Although staff still thought that they had to work too hard to finish a deliverable within deadlines, they now understood the rationale behind the estimate. Staff therefore accepted it for the time being, agreeing as a compromise with management to start working on a more advanced estimation method.

Earlier we described how the process agents as political agents supported the project leaders' campaign for project planning (see sec. 4.3). In the case of estimation a dialogue had been initiated with all individuals from the different stakeholder groups to trigger a different way of thinking and a more positive attitude with regard to estimates. The developers were used to working with deadlines that were not based on realistic estimates and overruns were normal. Thus, they did not doubt the benefits of an estimation method. However they, and to an even greater extent management, had some reservations concerning the usefulness of estimates. They were fundamentally perceived as lacking certain preciseness and the finality

that deadlines had. To resolve this contradiction, the process agents initiated a discussion about estimates as flexible devices for the distribution of resources and the management of work loads – less overworked staff would obviously be advantageous to both parties, and argued for the necessity of a trial. This being accepted by all involved, the process agents developed a very simple estimation method distinguishing between best, medium and worst case scenarios in terms of calendar and person days. Recognising that this method was purely functionalistic, it directed attention at the process of estimation and with increasing experience and feedback, it was subsequently changed and replaced by a more sophisticated approach based on collected data.

### 4.5.2 Following the IDEAL Model

Following the IDEAL model in the initialisation phase we acted entirely as technical experts to convince the organisation how we could help them to improve their development processes. We presented typical problems from other organisations, stated our knowledge about process improvement, and emphasised the benefits of a planned, structured course of process improvement organised as a project. Among other things we presented CMM's level 2 processes in detail.

In the diagnostic phase a tailored CMM-inspired approach was chosen to perform a specific appraisal and a more general organisational analysis. The project leaders completed a questionnaire especially designed for CMM level 2 assessments and development staff were interviewed before and after the questionnaire sessions. In all more than 50% of the employees were directly involved in these activities. In addition, documents were reviewed and observations were made. The questionnaires were completed while the process agents were present for necessary clarifications. The results of the interviews and questionnaire data were the basic material for the requested, quantified profiles. The answers from the questionnaires were then supplemented and substantiated by the interview results. For these the process agents had developed an interview guide that was based on the survey instrument, but which used more open questions. During the interviews the process agents asked the employees what they experienced as problems and not what a model like the CMM defined as a potential problem area. Thus, problems that had nothing or little to do with the CMM, e.g. the lack of structure to meetings were identified. The interviews were not merely used as a means to collect data, but also to generate a discussion and dialogue with and among the developers that were involved. Subjective opinions were expressed and the developers pinpointed not only problems, but also made significant proposals for solutions. Thus, the process agents did not simply act as technical experts, they also clearly acted as facilitators and to a certain extent as therapists in the interview sessions. Finally, however, as the process agents had to satisfy different stakeholders, an entirely functionalistic maturity profile as demanded by management as a part of an assessment report was produced and presented to the organisation together with other results and recommendations.

In the establishing phase the process group worked with three main tasks, namely a further refinement of the improvement proposals, a prioritisation of the proposals and the development and documentation of the final plan for action. The governing parameters for the prioritisation were to delimit extra economical resources and to delimit the additional workload for the employees. Through placement in a life cycle model for the product development it had become clear which improvement proposals fitted best to which development activities. We proposed radical change as some of the processes we suggested did not exist in the organisation. Although we recommended some measures that were not covered by the CMM, we undoubtedly used our technical expertise to make and support the propositions. The work in this phase was also influenced by the fact that all participants in the meeting where the diagnosis results were presented judged two acute problems as so important that they immediately founded two technical working groups to resolve these problems with the approval of management.

The first activity in the acting phase, which can also be considered as an establishing activity was the founding of the two working groups. Here clearly a participatory approach was taken. All employees were in line with their own preferences assigned to one of the two temporary groups. The process agents scheduled dates for first group meetings and appointed one person as responsible for the preparation of that meeting. They also participated in the first meeting of each group. Afterwards the groups worked on their own to develop

solutions that were acceptable to all staff.

In the leveraging phase at the end of the first cycle we collected the experiences of all involved and produced a process evaluation. One can argue that we did so as technical experts, but by exposing the intermediate results and the full report to working group meetings, by putting forward clear standpoints favouring certain stakeholder groups, and by using it in individual dialogues, this position could be challenged. As a result we applied the four paradigms much more consciously as shown in the case of introducing the estimation routines described above. This brings us to a more general discussion about the characteristics of the four paradigms and the overall usefulness of the framework, which will be subject of the final section of this article.

## 5. Discussion

We will now discuss and compare the four paradigms as archetypes by emphasising the main differences in their methodological approaches concerning the process agents' roles, their primary focus and interest and the applied data collection methods and investigation techniques as their basis for improvement work.

### 5.1 The Process Agents' Roles

Technical experts are distant observers, they attempt to be neutral and objectively analyse an organisation and determine a maturity level. Participating facilitators are actors, they want to support the understanding of actual development problems. Political agents are primarily observers, who detect conflicts, but are actors when they become involved in problem solving. Therapists are actors, but when they collect data they attempt to be neutral.

Both roles have advantages and disadvantages. An actor is not limited in the way in which possible problems are identified. However, it can be difficult to generalise from such data and it can also be difficult to distinguish what is a result of the agent's influence and what is an original insight from involved staff members. For neutral observers these problems do not exist, but their data is naturally imperfect as there are limitations of what they can see.

### 5.2 The Process Agents' Primary Focus

Technical experts have a focus on the chosen reference model and thus a mechanistic approach to software processes because they use the same process model to understand and design processes in many organisations. Technical experts are interested in deficiencies with regard to models and standards and aim at long term effects based on 'hard' empirical data. There is emphasis on 'physical' changes of standards, procedures, guidelines and change will often be implemented using an authoritative approach.

Facilitating participants have a distinctive focus on the actual processes being used and not on a predefined process model and thus have a more practice-based approach. The starting point is the organisation's current situation and its existing processes, products, characteristics and objectives. Participating facilitators are interested in satisfying the interests of different stakeholder groups. They initiate and take part in working groups where staff are involved in the development of specific organisational solutions.

Political agents are interested in the structural and power-related conflicts and contradictions, which exist in organisations. They use dialectics to analyse the situation and try to influence the relationships between different, conflicting stakeholder groups. By creating disruption in the organisation they provide a starting point for improvement proposals concerning changes in the organisation's structures, power relations, resources, and technical systems. In doing so they take a personal stand and support one side of the disputing parties. This allows both for model-based and individual organisational improvements.

Therapists have a psychological focus on individual staff members. They try to understand personal limitations and try to change and work with the individuals' capabilities and to support their personal development as a basis for improvement. This approach tends to concentrate on influential individuals like decision makers and opinion leaders.

The advantage of the mechanistic approach is that a reference model provides a good overview of the whole problem area and allows comparisons to be made and facilitates rapid initiation of improvements. The disadvantages are that the model might not precisely fit the organisations' needs and that a standardised solution might not actually improve the organisation's processes. Uncritically adopting a model as a basis for improvements, thus can result in a situation where the developed improvement proposals will not solve the actual problems and where staff might reject the

suggestions as they might feel that the model and the accompanying actions have been forced upon them.

The advantage of the more practice-based approach is that the improvements will accommodate the needs of the organisation and can be implemented early in the course of an improvement project as they focus on the problems the staff perceive in their daily work. In contrast to the mechanistic approach where the improvement strategy is almost provided up front before the problems have actually been articulated, this approach relies upon all stakeholders consensually agreeing upon what the improvement project should cover. Involvement reduces the risk of resistance, many people can influence the decision making process and rapid acceptance is possible. This requires significant competence of all those involved, otherwise the improvements will be spontaneous, uncoordinated and might only have a short-term effect. One might also work with the 'wrong' improvement because the developers' understanding about developing improvements might be insufficient. Finally, when the implementation of improvement actions is grounded in the agreement of all competing interests, very little might actually be improved because no agreement can be reached. Thus, this approach is a resource intensive process, especially if long-term impacts are aimed for.

The advantage of the dialectics-based approach is that social and organisational barriers are identified. Solving these problems and changing structures often might be a prerequisite for more technical process changes. There is however a risk that producing too much turbulence might jeopardise any improvement action. As conflicts and contradictions are evolving during change it might be hard to develop long-term improvement plans and to predict the effect of improvement proposals. There lies also a risk in the fact that political agents take one side only - especially management's side. As they take sides and deal with confrontations, they might not always be very popular and major resistance against change might come from the side, which they have chosen not to support. Finally, applying dialectical analysis might lead to a limited view: one might see conflicts and power relationships in everything and only focus on contradictions and not on processual problems.

The advantage with the therapeutic approach is that the process agents get close to the individual staff members' working life, which might make these individuals feel appreciated. They might subsequently aid and contribute to the process agents' acceptance in the organisation. Process agents will know staff better and individual improvement might be visible faster. These improvements might further increase the acceptance of the process agents and create a basis for further process improvements. The therapeutic approach however, demands considerable psychological competence and is a resource and time intensive process. It is therefore unrealistic to investigate the whole organisation and all the employees. There is a danger that an organisational overview is lost both generally and in the detail. It might also lead to a situation where many individual improvements are achieved, but only a few or none become commonly accepted. The therapeutic approach is limited to individuals and personal development is expensive. However, improvements that accommodate the single individual are identified and these may in some cases profit both the individual's development and the organisation.

### 5.3 Data Collection Method and Investigation Techniques

Technical experts build data collection primarily on quantitative methods, where model-based process improvement is based upon a rigid evaluation of an organisation in relation to the chosen reference model. Staff as informants and providers of data are treated as objects. Technical experts use questionnaires and surveys as investigation techniques to speedily and efficiently acquire a 'limited' amount of data from a large population. This data can then be benchmarked against the model using statistical methods to find compliance and deviation.

Participating facilitators use qualitative methods as they wish to gain a thorough understanding of a socially constructed work place. As the emphasis is upon sharing perceptions and achieving a consensus about improvements, all involved are seen as subjects. Participating facilitators will primarily utilise group interviews and discussions as they are interested in the exchange of opinions and in this way, different perspectives and arguments can be provoked and elucidated.

For political agents it is an explicit aim to objectify what has been brought to light subjectively. This can be done using a qualitative method to develop hypotheses and a quantitative method to subsequently verify

them. Thus a combination of debates, interviews and questionnaires can be appropriately applied. Staff are informants in the pursuit to find one truth with the help of dialectical analysis.

Therapists use qualitative methods as they wish to develop insights from value-based attitudes. They search for individual and unique problems and barriers that restrict personal professional development. Data collection is not that important, but how the informants are treated is. Thus as therapists want to explore situations and issues in depth, they use individual interviews and unstructured conversations as means of data collection.

Both data collection methods and the investigation techniques have advantages and disadvantages. Quantitative methods deal with explanations, qualitative ones with understanding. Qualitative methods are close to the data source. They are based on subjective statements and they aim to capture the specific and unique, whereas quantitative methods focus on the objective, observable, and verifiable. Questionnaires have the advantage of making the investigation repeatable. However there is a danger of misinterpretation and little or no possibility to go into depth. The major drawback of group interviews and discussions as a data collection method is that when no agreement can be reached or certain individuals dominate they can be ineffective. Finally individual sessions can be rather resource and time demanding.

## 6. Conclusions

In the research presented here, based on our practical experience, we reflect upon how process agents perform improvement projects, e.g. understand and change software processes. The reflection takes its starting point in the traditional, rational perspective, but shows how three other perspectives might contribute to process improvements. Examples from each of the different paradigms both individually and in combination have been used to explain the way process improvements can be stimulated.

The reflections on our project using the four paradigms and discussing their advantages and disadvantages have provided us with a better understanding of what we were doing. It helped us to recognise why the project was not a straight forward, rational process, despite the fact that it took place in the scope of the IDEAL model and the CMM. Utilising Morgan & Burrells's framework led us to deal with considerations, especially radical structuralistic and radical humanistic ones, which typically we would not have taken into account. After all, process agents are not supposed to participate in nor are they educated to deal with structural conflicts and to get close to people. This explains why we had to deal with what appeared to be anomalies with regard to the rational model that our work was originally based upon. However handling these not as problems and deviations, but as natural parts of software process improvement resulted in a successful project. This might be an argument for providing process agents with an enhanced education covering more than just technical knowledge, one that equips them with the necessary resources that allow for more than limited assessments and adjustments of the software processes they encounter during their work.

In summary, our work thus shows how process agents can use the paradigms more consciously in their improvement work by choosing the paradigm and its accompanying methods and techniques that accommodate and are appropriate for a given situation. The broader perspectives that have been presented here might therefore contribute to the wider diffusion and more successful application of software process improvement approaches.

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## Notes

[1] In this field also other authors, f. ex Nurminen (1988), Avison & Wood-Harper (1990), and Walsham (1993), distinguish different perspectives. Beyond that Dahlbom & Mathiassen (1993) provide philosophical considerations about diverse frameworks for systems development. Borum (1995) introduces an alternative framework for understanding organisational change in general and Kienholz (1999) differentiates viewpoints on inquiries as vital elements of learning organisations. None of these, although may be inspiring, will be discussed here.

[2] The usage of the male form is no expression of gender discrimination, but merely serves readability.

[3] These are pseudo explanations, they demonstrate statistical correlation between observable facts, but the statistics themselves can not give explanations.

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