Scientia
Interdisciplinary Studies in Computer Science
18(1): 15-23, January/June 2007

Formal models, flexible processes? Lessons from a socio-technical analysis of business process modelling

João Porto de Albuquerque, Marcel Christ

University of Hamburg, Department of Informatics
Vogt-Kölln-Str. 30, D-22527 Hamburg

{porto, christ} @informatik.uni-hamburg.de

Abstract

In order to achieve quality in software development processes, it has been argued that one must not only rely upon rigorous descriptions and models of processes to consolidate past experience, but also maintain flexibility in responding to new, unexpected situations. Aiming at examining the relationship between formal process models and flexibility, this paper presents a socio-technical analysis of a business process modelling project in an aircraft maintenance company. This analysis dialogues with works on the actor-network tradition, concluding that the relation between formal models and flexible processes is complex and multi-dimensional, and thus offering resources for a more comprehensive perspective of process modelling projects.

KEY WORDS: software quality, formal models to software engineering.

1 Introduction

The improvement of the quality of software development processes is frequently searched through a formal definition of the work practices involved. As expressed in the well-known *Capability Maturity Model Integration* (CMMI), a rigorous process description should clearly state its "purpose, inputs, entry criteria, activities, roles, measures, verification steps, outputs, and exit criteria" (CMMI, 2006). In this way, formal process descriptions combined with efforts to quantitative measurement and continuous optimization of processes are regarded as key factors to process improvement[1].

However, whilst compliance with formal process descriptions would lead to more predictability about characteristics of products and services yielded (and the associated resources required), a "blind" attachment to previous ways of working is harmful to the process flexibility, diminishing responsiveness to new, unexpected situations (Krause *et al.*, 2006, p. 272). Indeed, research on management and organization studies have controversially debated the trope *organizational flexibility* in the last years (Tienari and Tainio, 1999), with the common claim that organizational form cannot be fixed, but is rather an emergent property of relationships, such that "we must allow [organizational] form to change at a moment's notice" (Lee and Hassard, 1999, p. 401). As for the field of software development, there has been recently great attention to agile development techniques (Cockburn, 2002) that strive to give flexibility to software development by employing *light-weight* methods and rather informal processes with focus on "the use of light-but-sufficient rules of project behaviour and the use of human- and communication-oriented rules" (Cockburn, 2002, p. 8).

Looking at these two battle fronts, a software engineer may well pose her/himself the question: could we combine these two requirements (namely formalisation of processes *and* flexibility) in order to improve quality of software development processes?[2] Or are they contradictory, even mutually exclusive? From the viewpoint of the process definition, combining the two types of requirements above would imply elaborating process descriptions (and ways of dealing with them) to support practice with cumulative results of past experience, whereas at the same time keeping space for improvement and innovation that responds to changing situations and environment. In order to reason about how could a process improver achieve (or not) such acrobatic feat, we need a

[1] As reflected by the capability and maturity levels of CMMI (CMMI, 2006).
[2] Indeed, that is the question posed by Boehm and Turner (2003) in their comparative analysis of plan-driven and agile approaches.

better understanding of the relations between the design of process models and the actual use of these artefacts in day-to-day work practices. We contend that this can only be achieved through a socio-technical approach that does not separate social from technical issues, but rather considers the different factors entangled in the practices of technical design and artefact use.

In the pursuit of this goal, we following present preliminary results from an on-going research project that analyses the introduction of an integrated quality management system within an aircraft maintenance corporation (called AMC[3]). Since the analysed quality management project is based on business process modelling, this provides us with the opportunity of looking at the relation between formal artefacts (process models) and the situated practices that create and make use of the artefacts. Furthermore, we take into account not only modelling issues, but also other contextual factors, such as the underlying principles of the adopted quality management approach. This analysis is accomplished under a socio-technical perspective in dialogue with works of the actor-network theory tradition.

This paper is organized as follows: Section 2 briefly presents the research approach and the method used to gather empirical material. Sections 3, 4, and 5 respectively discuss the different phases of the analysed quality management project. Lastly, Section 6 discusses the results achieved and makes final remarks.

2 Research approach and method

Actor-network theory (ANT) is the name given to a rather heterogeneous body of work originated in science and technology studies[4]. It has been thereafter used in research on a number of different fields, including information systems (Walsham, 1997; Hanseth *et al.*, 2004; Monteiro and Hanseth, 1995). In the context of the present paper, the use of ANT has the decisive advantage of offering analytical instruments to overcome a view fragmented in social and technical factors, by means of an analysis of heterogeneous arrangements composed by human and non-human entities, such as people, texts, concepts, machines and others[5]. As such, as pointed out by Monteiro and Hanseth (1995), ANT provides a more specific consideration of technology than that found in other social theories. For the sake of brevity, we opted not to introduce the ANT approach here as it was already done elsewhere[6], but rather to try to make the concepts that we use clear within the discussions of the empirical case analysed below.

The case study analysed here comprises a quality management project initiated some five years ago in a large-scale aircraft maintenance company (AMC) in Germany. AMC has about 22,000 employees and is structured as a global network with twenty affiliates and subsidiaries. The empirical material was gathered by means of semi-structured interviews about the history and reasons of the quality management project, and by the observation of several modelling workshops.

3 Prologue

A severe technical failure during the take-off of an aircraft has triggered the change in AMC's quality management process that we analyse below. Shortly after take-off, the captain noticed an anomaly in the control of the aircraft. The left wing dipped, and the aircraft banked further left even though the captain responded with a sidestick input to the right. The first officer then took over the control of the aircraft. The crew could not fix the problem and found out that the captain's sidestick was reversed in roll. In spite of this serious technical failure, they managed to return to the airport. Later, further investigation revealed that two pairs of pins inside the connector of a board computer had accidentally been swapped during a recent maintenance.

This incident was the reason for the quality management department to start an initiative of re-organizing and re-establishing the existing quality management system. Up to this point, quality management was perceived by people in AMC as an inconvenient task required by the aeronautical authority. Indeed, there was a repository of operating instructions that should assure the quality of work, but it basically consisted of long documents and heterogeneous diagrams—which were now identified as the main source of failures. These documents were created by different business units, each using its own language and particular definitions of processes and roles. As a consequence, in order to track a business process through

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[3] All names of companies and persons are anonymised.

[4] See, for instance, Callon (1986), Law (1992), Akrich (1992); for discussions of later developments see Law and Hassard (1999), Latour (2005), and the on-line resource at http://www.lancs.ac.uk/fass/centres/css/ant/ant.htm.

[5] The symmetry adopted in the analytical posture is not to be confounded with the proposition of equivalence between humans and non-humans. It must be considered in the context of a relational ontology that does not take for granted *a priori* divisions between technical and social elements - for a good argument on this issue in the context of information systems see McMaster and Wastell (2005).

[6] See, for instance, Law (1992) for an introductory text in ANT, and Monteiro and Hanseth (1995) for the discussion in the particular context of information systems.

the different business units, one would need to read many documents with heterogeneous graphical notations, different formats, and divergent terminologies. Therefore, it should not come as a surprise that these documents were rarely used.

4 The Quality Management Project: defining problems and actors

The head of the quality management department thus saw the opportunity to start a new project to establish a new integrated quality management system. Based on the pressing argument offered by the aforementioned incident, it was not hard to convince the company's top management of the necessity of such an initiative: in order to improve the quality of work and to make business processes more transparent and manageable, a corporation-wide business process modelling initiative was started.

The Quality Management Project (QMP) was performed on a national level along about five years. It was aimed at gradually modelling the business processes of each business unit, so as to integrate all processes into a corporation-wide, easy-to-use *process map* that could be used by employees to visualize the processes - thus getting rid of the old text-based documents and non-standardized diagrams.

The process map used a graphical representation of the airport and aircrafts at its highest level, from which the process models related to specific units could be retrieved by selecting the corresponding part of the airport or aircrafts. As such, this graphical representation created a *process architecture* to structure the processes carried out by the existing business units, giving and overview of the mutual relations between processes and units, and thus improving the usability of the tool.

4.1 Modelling framework and tool

The process modelling tool chosen was the standard software ARIS Toolset (*Architecture of Integrated Information Systems*, see (Scheer, 2000)), but its diagrams were adjusted to the needs of AMC in respect to process representation. Before the process modelling initiative began, a survey among the employees was performed in order to collect as many opinions as possible and identify the most accepted modelling technique. As a result of the survey, QMP opted for non-executable swimlane- and role-based process landscapes, combined with classical organization charts to display the role hierarchy.

Figure 1 gives a flavour of how a process diagram using the adopted notation looks like. Swim lanes (the horizontal subdivisions) separate the activities (e.g. *"check technical document"* and *"if needed correct structure"*) that are performed by different roles (correspondingly, *"employee (DSC)"* and *"central process custodian technical documents"*). In the diagram, the higher-level process to which the current diagram pertains is

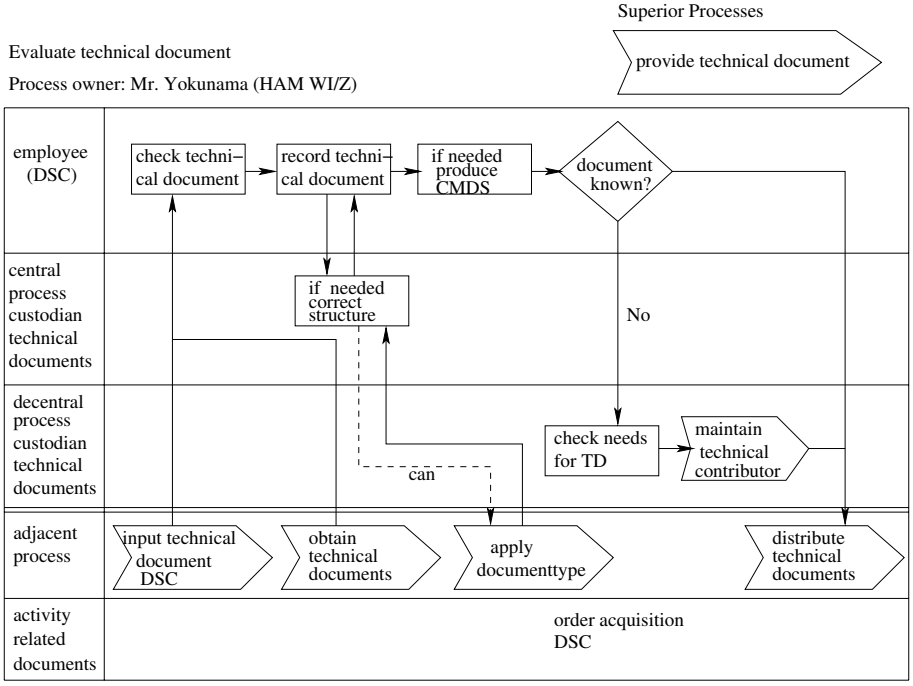

Figure 1. Example of an AMC process model.

represented as a superior process ("*provide technical document"*), and other related processes are depicted as "adjacent processes" (for instance, "*distribute technical documents"*). The corresponding organigrams are omitted here for the sake of brevity.

Each employee in AMC belongs to a business unit. Each business unit is connected to several roles, so that each employee is mapped to one or more roles - which in turn can be mapped to several processes. The roles are thus used in two ways: on the one hand, they are used to represent in organization charts the hierarchical relations between units, and on the other, each business process is assigned to roles that are responsible for it. In this way, roles can be used as a filter to produce a specific view of the business process repository. For instance, if an employee belonging to the business unit "HAM WI/ZW" (as in Figure 1) logs in to the quality management tool (either by entering his role's name or by navigating through the aircraft-like graphical interface mentioned above) only the processes that are associated with the roles of "HAM WI/ZW" are displayed. This mechanism is supplemented in the tool with ordinary functions for "search by process name" and "search by role name".

4.2 Problematisation of actors and interests

Although the focus of our analysis lies upon the modelling processes (further explored below), it is useful to start briefly analysing the establishment process of QMP. In this context, we consider the process of building a system of alliances around the quality management system, which is initiated by the quality management department. This process results in the interdefinition of the identity of the actors involved, in what Callon (1986) calls *problematisation*.

In our case, the quality management department must interact with: (a) the managers of business units; (b) the employees of each business unit; (c) the modelling tool[7]; (d) the aeronautic authority. If the project is to succeed, the support of each of these groups must be assured. They are thus defined from the viewpoint of the quality management department as follows:

Business Unit Managers: are interested in improving the quality of the business processes in their units. They are also assumed to be able to request employees in their units to engage in the project.

Employees: have practical (tacit) knowledge about business processes, but their practices are uncoordinated and sometimes have conflicts. They tend to have a critical stance on quality management, since it may imply in additional work to what they "already have to do". However, they are interested in supporting tools that facilitate their activities.

Modelling Framework/Tool: provides standardisation of processes and better visualisation trough the representation of work practices as business processes.

Aeronautic Authority: wants to have transparent access to processes in order to verify compliance with rules and regulations.

In this manner, actors were defined by the quality management department in such a way that QMP was seen to be relevant, and even necessary, for their particular interests. In the ANT literature this process is called *interessment*, resulting in that QMP becomes an *obligatory passage point* for the actors to reach their goals (Callon, 1986).

While the support of managers and authorities are perceived to be quite straightforward considering the definitions above (once the project was approved by the company's top management), achieving the support of employees demands more effort. Although they could be extrinsically motivated by their bosses to participate (e.g. to give input to process modelling), if they don't regard the project as beneficial - but rather as a useless burden - they might provide incomplete or incorrect information. Moreover, if they do not actively use the resulting process repository to orient their practices, the whole project will be rendered innocuous. As such, the quality management department needed a strategy to co-opt employees, convincing them that they will profit from the project - or, an *interessment device* in Callon's terminology (Callon, 1986).

The argument put forward for this end was two-fold. Firstly, the better visualization of processes afforded by QMP would, according to the quality department, contribute to a better coordination of activities, thus making the work of employees easier. Secondly, and more importantly, the intent of QMP was not to document every competence of employees - i.e. everything they *can* do - but rather to catalogue the things one must *know* in order to do a good job in each business unit[8]. As such, a process model should not be considered as a substitute of the tacit "know-how" of employees, but rather as a complementary resource to practice. This argumentation was also crucial to prevent employees of having concerns about becoming unnecessary (and thus vulnerable to be fired) due to the exposure of everything they know. This fear of process

[7] Notice that ANT uses the analytical principle of extended symmetry (Callon, 1986) that takes into account the role of technical artefacts in negotiation processes. For this reason, actors are also called actants - a term borrowed from semiotics, see also (Akrich and Latour, 1992).

[8] The terms used in German build a nice play of words: the focus was not on *können* (can) but on *kennen* (to know).

"*rationalization*" is also connected to the remembrance of related management programs (common in the 1980s and 1990s) such as *downsizing* and *business process reengineering*, which frequently aimed at personal reduction - the fear can be seen here as an *anti-program* to the project, in Latour's parlance (Latour, 1999).

In this manner, the quality management project starts with the establishment of a system of alliances between the involved actors, which in turn (re)defines their interests and groups them around common goal. Moreover, the quality management department strives to raise the interest of the other actors for QMP, in order to avoid that they associate themselves to other conflictive entities (e.g. the fear of rationalization mentioned before, but also other vendors of different modelling tools, for instance). This establishment is depicted in Figure 2 (adapted from Callon (1986)). The project will only be effective though, if the modelling is successful and the process models are used in practice - and this leads us to the modelling workshops.

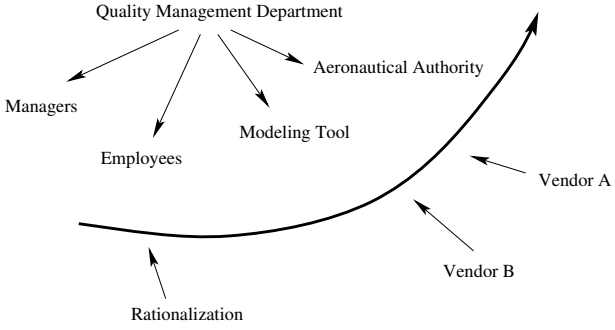

Figure 2. Interessment of Actors.

5 Modelling workshops: mobilizing and inscribing

The modelling of business processes were carried out in workshops conducted by a modeller from the quality management department with up to ten (mostly three to six) employees as representative of their business units, e.g. repairperson (factory work floor), lawyers (legal department), traders (sales and insurance departments). Each representative was interviewed by the modeller about the most important activities performed, decisions made, and data used in her/his work. Based on the answers, the models were interactively drawn and projected on a big screen. Each modelling session took up to three hours, and at the end all modelled processes were shared via e-mail among the participants for a final inspection and feedback. If necessary, participants would agree to meet again on another modelling workshop to improve or change the model.

Recurring to the ANT vocabulary, we can say that the employees of a certain business unit are *mobilised* (Callon, 1986, p. 198) through the representatives that act as their spokesmen in the modelling workshops. The representatives are thus assumed to report about the work practices of all absent employees they are representing, whereas these absent employees are expected to accept the result of the negotiations that take place in the modelling sessions, and effectively (re)orient their practices according to the models finally achieved. Of course, these assumptions must hold true in practice in order to the *enrolment*[9] of the actors be successful.

With the introduction of the process-based modelling tool in QMP, each business unit now had to designate a person to fulfil the role of *process owner*, whose responsibility is (a) to control and (b) regularly update the processes of the corresponding business units (there are processes that connect different business units). The final versions of process models are then inspected by the process owners who decide whether processes are correct and are ready for the final *conformity check*. The conformity of the process in respect to the requirements of the aeronautical authority is thus verified by employees of the quality management department. Once this last check is executed, the process is integrated into the process repository (process map) and goes "live" - it can thus be accessed by all employees of AMC.

In this process, the figure of the *process owner* functions as a key component for achieving the enrolment of the represented employees. As mentioned in Section 3, before QMP was started there was no conception of "business processes", and the existing disconnected operation instructions and diagrams were mostly (consciously or not) ignored by the employees. With QMP and the modelling formalism used, the assignment of an *owner* to each process - which was already *inscribed* into the modelling technique - is made mandatory. The process owner is thus the responsible for the accuracy of the process model, what entails both ensuring that model reflects the work practices and seeing that everybody's practice actually complies to the model.

[9] The metaphor *enrolment* "designates the device by which a set of interrelated roles is defined and attributed to actors who accept them"(Callon, 1986, p. 186).

5.1 Negotiations and conflicts: inscribing organizational practices

During the modelling sessions some interesting discussions among employees took place - as well as unexpected phenomena. During the interactive modelling and visualization of the models, work processes, roles, and hierarchies must be *explicitly* described. This caused employees to disagree about certain aspects of the activities being modelled, such as: (i) who should execute them and who is the *process owner* (*responsibility conflicts*), (ii) who else is involved and why (*interface conflicts*), (iii) in a sequence of activities: who is the first and why (*role conflicts*)?

What we see here is a negotiation concerning the shape of organizational practices and the *inscription* (Akrich, 1992) of these practices into formal artefacts, i.e. the process models embody and *prescribe* determined associations of the elements in the organization[10]. These elements included people, tasks and the relationship between them - which were correspondingly represented in the models by roles, activities and sequential links (see Figure 1).

Thus, although no radical restructuring process of the organization (like a "big" business process reengineering) was being performed, the organizational form - in the sense of the practices that give shape to the organization - was being renegotiated and remodelled. The different actors (or groups, or units) had different sets of practices, which yielded different, co-existent organizational forms. In the modelling though, these practices were confronted and some of them were perceived as incompatible and conflicting.

Up to the moment, such "conflicts" were dealt with on an individual basis (informally whenever they happened), such that they were actually not identified as conflicts. But now, along with the visualization brought by the graphical representation, an "official" version was being produced, and the actors involved in the modelling (the unit representatives and the modeller) struggled to have their "versions" of the organizational practices *translated* in the process models. Clearly, this was directly connected with the position that the process models have in the QMP network[11], for, as argued by Suchman, representations of work practices always serve interests (Suchman, 1995). In the context of QMP, the process models are expected to orient future organizational practices, and building upon the ANT concept of *prescription* (Akrich, 1992), we could say that the models inscribe *organizational prescriptions*, i.e. they prescribe certain organizational orderings.

As a result of the negotiation, we can thus say that each modelling session builds a network around the business process model obtained, aligning the actors involved and *translating* their interests. The network corresponding to the whole project (QMP) can be seen to arise from the agglutination of the networks of each process[12].

5.2 More conflicts and betrayal

Interestingly, not only the model "contents" but also the very notation formalism was subject of controversy. Such conflicts occurred in the modelling of processes that had an inter-organizational character, connecting different business locations. Those processes were critical because they prescribe the way how data and activities are passed from one location to another. In the modelling technique adopted this relation is represented by an arrow that goes from the sender to the receiver. When modelling such processes, the representatives of different units interpreted this notation as defining a hierarchy relation between the business locations. The sender location was seen as higher ranked, since the receiver was "dependent" on the given data and must thus conform to the activities performed by the sender.

Consequently, there was a conflict in the modelling sessions between two different possible arrangements (or *programs of action*) involving the notation. The modelling formalism incorporated in the tool pressed for a separation between a process-oriented description of activity sequences (represented by process models) and the hierarchical organizational structure (depicted in organization charts), thus suggesting the arrows between sender and receiver to be associated to sequential, non-hierarchical connections. This arrangement was inscribed in the tool and was defended by the modeller during the sessions[13]. On the other hand, the employees saw the opportunity of translating via this notation a relation of hierarchical superiority into the process model, and lively argued over the precedence of the activities

[10] As stated by Akrich (1992): "technical objects define actors, the space in which they move, and ways in which they interact" (p. 212).

[11] Understood here following the ANT tradition as arrangements of heterogeneous elements - see for instance (Law, 1992).

[12] This separation is only an analytical one (or a possible framing), for the networks are in fact deeply entangled and constitute a unique whole.

[13] We could say that the quality management department (puntualised as the actant modeller) *subscribed* to the prescription inscribed in the formalism (Akrich and Latour, 1992).

to be performed by each one. In this manner, this example shows that even the formalism itself can be enrolled in practices to serve interests other than the ones for which it was originally designed and thus betray them (the artefact is then de-inscribed (Akrich, 1992))[14].

5.3 Flexibility and/or irreversibility?

Now that we have analysed the socio-technical negotiations involved in the modelling of business process of our case study, we are ready to approach our initial motivation by asking: How flexible are the organizational practices engendered by our quality management system? In order to analyze this question we will oppose flexibility to the concept of *irreversibility* as defined by Callon (1991). The degree of irreversibility of a translation is said to depend on two things: "(a) the extent to which it is subsequently impossible to go back to a point where that translation was only one amongst others; and (b) the extent to which it shapes and determines subsequent translations" (Callon, 1991, p. 150).

According to the quality management department, the approach of QMP is based on flexibility and the amount and the nature of processes, organization charts, and roles are changing constantly. Indeed, the quality management tool provides a feedback function with which any employee may request model updates[15]. The requests are then first checked by the process owner, and if considered reasonable, they are passed on to the quality management department for the conformity check (see Section 5). After a successful check, the modified model is committed to the process repository.

In this manner, the process models remain (at least partially) negotiable in the QMP network. This gives the network a certain degree of flexibility that prevents the organization from becoming completely irreversible, i.e. from becoming an automaton-like network that "transforms its actors into docile agents and its intermediaries into stimuli which automatically evoke certain kinds of responses" (Callon, 1991, p. 151). Therefore, with the negotiations of representatives in the modelling workshops and the possibility of model update requests by any employee, channels are kept open to enable changes and incremental innovations in the processes of the organization.

Both the roles acquired by the employees and by the process models in the QMP network are thus crucial to preserve this level of flexibility. The employees are not mere 'executers' of rational processes optimally designed by outside experts, but rather active problem-solving agents and process designers themselves. Conversely, the process models assume the role of orientating devices for practice (and not of fixed rules to be followed), which can be updated and renegotiated[16].

Does that mean that QMP yielded a completely reversible network, such that all associations knit along the way can be easily untied and renegotiated? Probably not, since in network building processes - especially those which involve translation strategies that rely upon material artefacts - the obduracy of the relations established is more often than not an important goal (Law, 1992). If we look carefully to the updating process described above, we see that the ways to introduce model changes are not arbitrary, but must rather follow a very well determined procedure. The sequential procedure to request a change necessarily pass by: (a) the tool; (b) the process owner; and (c) the quality management department. The first interesting point to note in this procedure is the degree of irreversibility of the *process owner* assignment. Unlike the form of process models, a revision mechanism for the assignment process-owner is not provided; instead, each change request reaffirms the association of the owner with her/his process by making sure s/he is aware of and in accordance with the changes introduced into the model. As such, while process models are kept updatable and are provided with some flexibility, the *distribution of responsibilities* accomplished by the owner assignment has a higher degree of irreversibility.

The distribution of responsibility is also the main reason for the conformity with legal regulations to be verified by the quality management department. Indeed, the QMP network has configured the responsibilities in such a precise way, that each group of actors was made accountable for specific parts of the overall modelling process. This fact was practically exemplified by an anecdotal (yet real) story related by an employee of the quality management department. Whenever an aircraft maintained by the company falls, there would be a great rush in the quality management department to know what was the detected cause of the failure and then to perform a comprehensive

[14] It thus corroborates Bowers' argument that "[f]ormalisms are *soft or plastic* in their significance, their meaning or what should be done with them are open to negotiation" (Bowers, 1992, p.256, original emphasis maintained).

[15] In an interview with members of the quality management project, the claim about the frequently updates was endorsed by showing the high usage levels registered in the tool statistics.

[16] As argued by Suchman (1987), plans should be seen not as formal structures to control practice, but as resources used in the contingencies of situated action.

check in the corresponding process models and the relevant regulations. If it was determined that the model was compliant with the rules, everybody would take a deep breath and relax, since it was not their fault.

This example shows the strength of the distribution of responsibilities established in the project network by the best way to do this: putting its irreversibility to the test (Callon, 1991, p. 150). In situations of crisis like this, many competing translations arise, in which different articulations of the network elements try to impute the responsibility for the failure to the different actors involved. Here we see that the strength of the responsibility links inscribed in the QMP network entails a irreversibility degree that does not allow space for contend about the accountability of the different actors. Whilst the conformity of models to official regulations is responsibility of the quality department, the process owner is accountable for the accuracy of the model in respect to practice, i.e. s/he must ensure that the actual work practices are in fact carried out in the same way (or in a near-enough fashion) as they are depicted in the process model.

As such, we see that we must further qualify our initial indagation about flexibility in order to differentiate between the several types of associations included in a project's network. In this case, the associations drawn in process models (the sequence of activities of each process) are kept more flexible than the distribution of responsibilities assigned by the arrangement of actors in the project.

6 Discussion and final remarks

We have sought to exemplify the use and usefulness of a socio-technical analysis to give insight about different aspects of the modelling of work practices by looking at the particular context of business process modelling in a quality management system. Our approach pursued a dialogue with works on actor-network theory, enabling us to see process modelling as a socio-technical activity in which technical and "non-technical" issues are indissociable. We believe that this analysis enables us to reflect about the practice of software engineering in a number of ways, two of which we following outline.

The first point is related to how we ought to regard models. In software engineering and computer science, as a heritage of a modern science tradition (see Teixeira, 2006), models are frequently regarded as technical entities that obey formal syntactic rules and are interpreted (or better, executed) according to a rigorous semantic. Under this lenses, everything that cannot be directly expressed in the formalisms of models is either badly understood or it is dismissed as a "non-technical" noise. Although this logical view of models (akin to a positivist epistemology) may have its merits in some contexts (as for example in theoretic computing) a very different picture from models arises from the socio-technical analysis of the case study above.

When we regard models within the practices of model development and use, we see that the 'technical' aspects are inextricably linked to a series of other elements that not only *influence* the technical questions as external disturbances; instead, models and 'non-technical' elements co-constitute each other within the continuous movements of social[17] practices. Clearly, this is of particular importance in the context of software engineering, and particularly in software process improvement, in which models are used to guide and support human activities. Looking at the analysis of modelling workshops of Section 5, we see the form and meaning of models resulting from negotiation processes between all actors (human and non-human) involved. On the one hand, the achieved models inscribe intentions, prescriptions of organizational forms, interests and visions of the world - thus helping to configure the social space in which they are used. On the other hand, the model elements (and even the notation formalism) are associated in the social practices with elements different from those originally foreseen - altering the very meaning and significance of models.

Based on this socio-technical view of models, a second point can be made from the analysis of flexibility in the quality management system. Although formalisation and flexibility are frequently considered antithetic poles of a unidimensional axis, the case study analysed above suggests a different picture of the relationship between the formalisation of work practices into business process models and the flexibility of the organization. Using the concept of irreversibility, we could see that the translations performed with the formalisation into process models have made some associations more irreversible than others. In respect to the activities performed by employees, a reasonable degree of flexibility was achieved through the possibility of systematic revision of models. Decisive factors for this were the roles acquired by models and employees in the socio-technical network, based on a view according to which formal artefacts and informal practices are not mutually exclusive, but rather complementary. On the other hand, the flexibility of processes does not mean here that all elements of the project analysed are only loosely connected and their associations are not binding:

[17] Understanding "social" with Latour (2005) not as a separate realm or dimension of reality, but rather as a type of association (p. 1-8).

The distribution of responsibilities that emerges from the project have proved very robust. Indeed, the formal attribution of process ownership and conformity assurance reduces the margin for dispute in case of a technical failure, i.e. it reduces the flexibility of the negotiation of responsibility.

In this manner, we see that the relation between formalisation and flexibility is much more complex than the zero-sum game implied by the (commonly assumed) unconditional negative answer to the question in the title of this paper. Our analysis shows that the flexibility and/or irreversibility related to a formal model should be analysed in respect to different dimensions, according to the associations that compose the socio-technical network in which the model takes part. We think that this lesson is of great value for a software process improver (and, more generally, for a modeller) in the consideration of the whole complexity of the socio-technical arrangements s/he contributes to build.

Acknowledgements

We would like to thank Edgard Whitley and Antonio Cordella for their very helpful comments on earlier versions of this paper. We are also indebted to Arno Rolf and the members of the Mikropolis network for our insightful discussions in the group. Last but not least, the first author gratefully acknowledges the financial support of the Alexander von Humboldt Foundation and the travel grant given by the Foundation University of Hamburg, without which this work could not be realised. Customary disclaimers apply.

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