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Understanding Modelling Practices in Manufacturing

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Abstract

This paper is about describing and analysing modelling practices in automotive industry and electronics design. Based on ethnographic observations in modelling sessions in three case studies, we tried to describe the modelling scope in real work environments. This helped to identify problem areas or areas of change, articulation work in decision making activities during modelling, models as shared objects and issues of accessing the models by different communities of practice. The focus of our investigations was on a specific modelling environment called Active Knowledge Modelling (AKM).

1. Introduction

Modelling is a state of the art methodology in several sciences and practices, e.g. in knowledge management, organisational design and development, computer science especially in software engineering. There are several modelling languages and notations established. Additionally, several notations and approaches have been developed to guide modelling processes. These have partly different objectives and are used for different purposes. Some organisations use modelling as a methodology to re-design the organisational structure, create new products or variations of current products. Modelling is usually not only carried out by specialists, but also by actors working in the enterprises. These actors have normally different background, different work settings and different level of knowhow about modelling. Their tacit knowledge about their work practices vary and this is an asset especially in case of reorganising or redesigning companies' products.

Studies to understand modelling scope in real work environments enabled identification of the use context and user requirements to modelling processes, approaches and tools (Tellioğlu et al., 2007). They observed and analysed different modelling sessions in several case studies and described some issues showing qualities of modelling as a process and of models as artefacts. Others tried to define requirements for an ideal object-oriented modelling language by comparing these with the achievements of UML and other object-oriented modelling approaches (Engels and Groenewegen, 2000). Curtis et al. found process representation as “a vital issue in redesigning work and allocating responsibilities between humans and computers” (1992, p.75). They defined five basic uses for process models: facilitate human understanding and communication, support process improvement, support process management, automate process guidance and execution support. For these reasons, process models are applied in manufacturing for a

long time with more or less success in acceptance by users and improvement of efficiency in process management.

In this paper we try to understand the modelling scope in real work environments and through this to identify problem areas or areas of change, articulation work in decision making activities during modelling, models as shared objects and issues of accessing the models by different communities of practice. Our investigations were carried out in the scope of a European STREP project called MAPPER (Model-based Adaptive Product and Process Engineering) (IST-016527) with the objective of enabling fast and flexible manufacturing by providing methodology, infrastructure and reusable services for participative engineering in networked manufacturing enterprises, demonstrating practical benefits and scientific values in three industrial pilots.

In the next section we will describe our methodology and the study environment. The section 3 is about modelling with active knowledge and about issues that we could identify in analysing the real modelling environments before concluding the paper.

2. Methodology and Our Study Sites

We investigated several modelling sessions carried out at all use sites. Our methodology is based on observations to provide an inductive, ethnography-based description of modelling processes. Observations of modelling sessions are based on multi-sited ethnographies. We observed modelling sessions, gathered data by audio and video recording. Then we analysed our ethnographic data, user documents and models created in these sessions. The first modelling session was held in December 2005 concerning the research centre of a vehicle production company (*Alpha*). The second was in February 2006 and concerned a company producing parts for cars (*Gamma*) like seat heats, gears etc. The third modelling session took place in March 2006 and regarded a small electronics company (*Beta*).

We considered several issues in our investigations during modelling sessions: the work taking place preliminarily to modelling (e.g. training sessions, structured interviews); practical means by which the process of participative engineering takes place in modelling sessions: tools that support the process of modelling other than the model and the setting of the scene (public presentations, open discussions, roles); problems encountered by end users in modelling sessions: are users able to think in four dimensions in the sense of POP* approach (which was the main modelling approach applied in MAPPER), are users able to present their problems in terms of present and wanted situations; collaboration between coordinator, modelling expert and coach: how they coordinate their work in the modelling sessions, how is homework distributed from a modelling session to another; situation coaching: the use of the POP* approach; management of model files: how do they circulate, when do they circulate, are there inscriptions or guidelines used to circulate the models, are there additional documents presenting the results of modelling sessions. These issues show how much attention is given to details of the scene and modelling situation, processes around modelling, interactions between actors, collaboration and coordination work carried out during and between the modelling sessions.

The modelling session we observed in *Alpha* had the focus on a current model of Target Setting Process. Target Setting Process is the process of definition of the technical and economical objectives that will drive the vehicle development until the production. Its aim is to ensure the achievement of the satisfaction of the customer by means of the definition of product specifications coherent with the performances expected by the customers. The present (as-is) model was created with the MERISE methodology. The application of AKM was oriented to detail the elements already present in the current model and to restructure their organisation in projects, their products, processes and infrastructure. The problem encountered was that the product description represented in the MERISE model is a document and that this document actually contains a lot of activities, which could not be represented in the model explicitly. The participants of this session were two domain experts, a facilitator and a modeller. Domain experts asked the modeller how to represent documents in AKM. The modeller provided the technical solution. An additional problem was to represent different versions of these product descriptions with active knowledge models during the whole Target Setting Process. Domain experts questioned IDEF as a definition language several times. They wanted to better understand its application and to discuss its usefulness for their purposes (Figure 1).

Figure 1: Some impressions of the modelling session of Target Session Process in *Alpha*: A domain expert shows his model to others (upper left), several meta-models to choose from as a base for the model-to-develop (upper right), facilitator discusses several issues with domain experts (lower first), domain expert explains the old models to facilitator (lower second), modeller tries to understand the technical problems of the domain expert (lower third), everyone works on his/her computer with the modelling tool on it (lower forth).

The modelling session in *Beta* had the goal to foster the comprehension of design processes by its partner and find points of collaboration for the future. The use case manager, three domain experts and a modeller were participating the session (Figure 2). Modelling has been seen as a cultural facilitator for the collaboration between *Beta* as the producer of virtual components and its partner as the producer of analogue circuits. During the modelling session enterprise models of *Beta* designed by *Beta's* engineers

were checked and corrected by the modeller. Afterwards, a model of *Beta's* partner's design process was built.

Figure 2: Some impressions of the modelling session in *Beta*: Setting up the modelling environment (first), using the paper-based artefacts (second), trying to use the modelling tool (third), being alone with the models and modelling environments (forth).

In the modelling session of *Gamma* there were a use case manager, two domain experts, two facilitators, a coach and a modeller (Figure 3). The goal was to design the Process of Innovation in the enterprise. A number of modelling sessions have already been carried out in advance. The modelling session observed was the first session aiming to deliver a solution model based on a requirements model created previously. The two main questions were: How does innovation happen when it happens? How can domain experts learn from the innovation taking place? The solution model should contain task patterns[1], the use of MAPPER services to evoke and integrate these task patterns and product design alternatives.

Figure 3: Some impressions of the modelling session in *Gamma*: The modeller was busy working on the model on his computer (first), the group was sitting around for the whole modelling session (second), a domain expert was explaining their work activities by using his documents (third), the coach tried to answer arising questions and explain concepts of modelling if necessary (forth).

3. Modelling with Active Knowledge

"A *model* is an abstract representation of reality that excludes much of the world's infinite detail. The purpose of a model is to reduce the complexity of understanding or interacting with a phenomenon by eliminating the detail that does not influence its relevant behaviour. Therefore, a model reveals that its creator believes is important in understanding or predicting the phenomena modelled. Selecting bound for the

[1] We use the term task patterns to refer to adaptable models capturing best practices for the task under consideration. Task patterns are not only valid and applicable in one organizational unit, but in most cases also relevant for other organisation units and processes and even for other organizations or enterprises.

phenomena to be modelled depends on the uses to which the model will be put" (Curtis et al., 1992, p.76).

The purpose of the modelling with AKM approach (by using Metis as AKM modelling tool) is to create a map of the enterprise and use this for a number of things like quality control, documentation of the organisational structure, definition of responsibilities for different parts of the product (Modeller[2] in *Beta*). Additionally, business consultants normally use models as communication tools, managers as training tools for newcomers in the company or to support the redesign of the infrastructure or business processes including the organisational structure of an enterprise.

Modelling sessions are not only for modelling the objects, structures and relations, but to create a common understanding about the objects-in-development, ongoing work processes, roles and skills of persons involved and relationships between all these elements. Models and modelling can facilitate communication, cooperation and mutual understanding between different disciplines. No matter which modelling tool is used, which modelling approach is applied, it is important to consider modelling as a mediating process between different communities of practice (Jordan, 1993).

In the following we describe some results of our analysis of modelling activities on the use sites.

Identify problem areas or areas of change

Modelling helps identify problem areas in an organisation like communication gaps, boundaries for knowledge sharing, missing of common understanding of goals, products, organisational and temporal structures, responsibilities, complexities etc.

Modelling helps overcome complexities. With a model, one can map complex relations in an organisational context in an easy way. Objectives can be weighted and this can be used to allow "what if" analysis e.g. in case of organisational development or re-organisation of a company or new combinations of current products to new ones. AKM approach provides four dimensions to enable flexible combinations of different issues: Process, Organisation, Product and System (POPS or POP*) (Figure 4).

[2] This modeller is the co-founder of the AKM approach and the tools used to support modelling based on AKM.

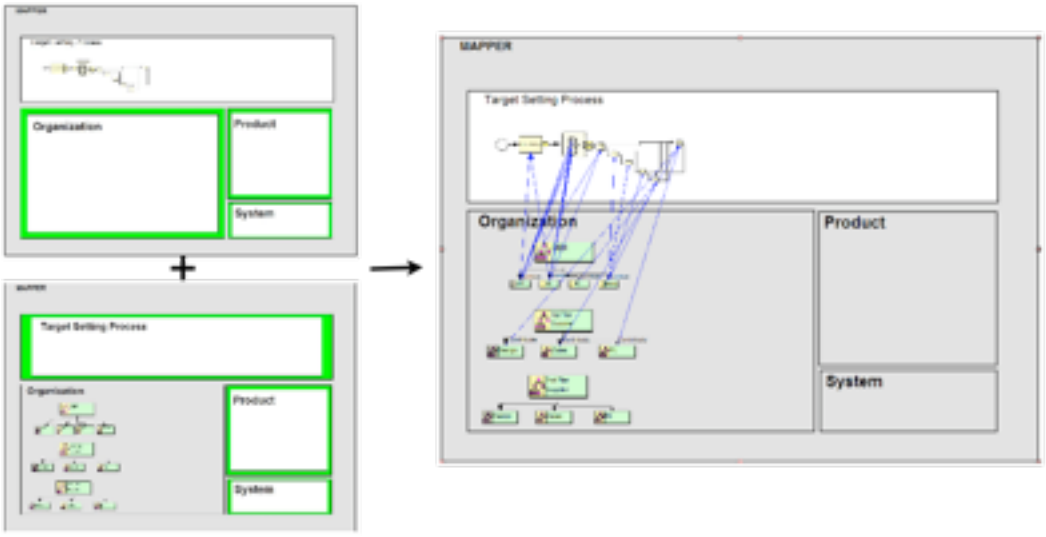

Figure 4: The result of the POP* model of *Alpha* after the modelling session: the relation of Target Setting Process to Persons of the organisation.

Articulation in decision making activities during modelling

There are several types of decisions made during a modelling session. Modelling is itself about abstracting information and knowledge from a particular domain (Kaindl et al., 1999). This means that everything that is represented in the model needs to be identified in and selected from the real domain and people involved in modelling have to decide which ones are relevant and which ones are not. Modelling a work process contains content, format and sequencing of information that domain experts need to do their job. It is necessary to identify these elements and decide to choose for the models.

Modeller in *Alpha* made a choice concerning which meta-models to install on domain experts' computers for the modelling session. The model of the meta-model serves other modellers or users to understand what the rules of the meta-models (or templates) are. It shows how the meta-model is. It contains all the classifications and structure inherited by the meta-model. Domain experts are not involved in the decision of choosing the appropriate meta-model, because it is a "technical" issue. For this modeller in *Alpha*, a model is substantially a representation with boxes showing objects related to other boxes showing other objects. He can identify these objects in his (ITM, Information Technology Management) meta-model. This enables him to communicate his understanding of modelling. He also tries to explain how the AKM approach is meant to be used: "It is like a war room: The idea is that for each wall of this room you have different models representing different domains. You have an expert for each of these walls and when you are in the middle, you just can give a look to all these models and try to see the connections between process and organisation, process and system".

In *Gamma*, it was not clear to domain experts how to model tasks and processes of designing new car parts by considering the multiple parameters. The work sequence was of course familiar to domain experts, but relating data especially when it comes from suppliers to the processes was another step to design. Domain experts tried to communicate their knowledge and experiences about production of car seats e.g. and

demonstrated their documents and exchange with colleagues and suppliers outside. Modellers and the facilitator had to find out how to model these activities by considering the current content and relations between subtasks and artefacts. The decision making process is mostly prepared by modellers showing the possibilities to model certain situations in work procedures. Domain experts could only reflect and rise their voice if the model was not corresponding to the real activities. Otherwise the decision about the technical presentation or the use of meta-model elements was carried out by modellers without involving the domain experts.

During setting up the first modelling session in *Alpha* it was not clear which notation should be used in the new models. The old models are created with MERISE, the new models should be produced by using Metis which uses its own templates like ITM. One domain expert had experiences with IDEF and suggested to use IDEF in new models. Because no one from the participants knew how IDEF notation looks like, this domain expert explained on a white board the rationale of IDEF by giving some examples from the real work setting (Figure 5). In that case it was important to show the knowledge about the notation and explain how useful it can be for modelling purposes.

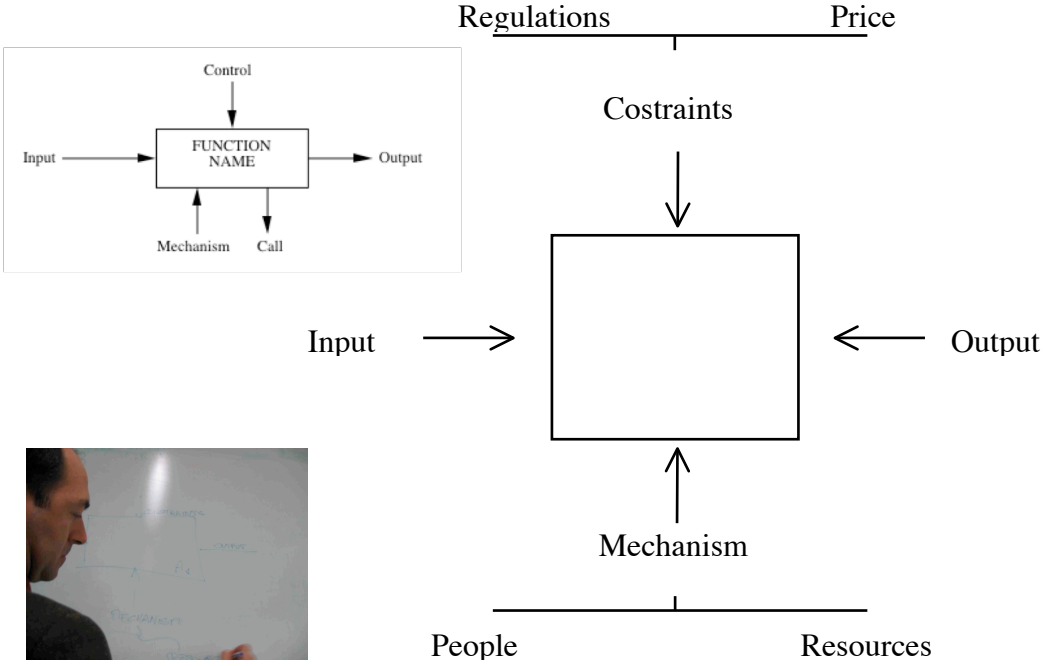

Figure 5: A scheme of IDEF notation drawn on the whiteboard by a domain expert in *Alpha*.

Models as shared objects

Models can be used as shared objects to establish communication and cooperation between collaborating actors or companies. By modelling the processes or products actors share their knowledge and create a common understanding.

If there is a need to integrate the models of two companies working together, models need concepts to implement this. One of this concepts is building a hierarchy between the models. Another one is creating sub-models. Sub-models can be taken and put

together in one model but the sub-model itself can also work separately. Practically, this type of integration means to copy a model into another without maintaining the independence of both models.

Access to models

However, there are some problems in creating and using models in organisational context. First, although models are rich representations of things they model, it is not always possible to access them. Especially, domain experts have normally limited access to all model files as well as to templates and meta-models. There are six different modelling templates for different kind of companies. The modeller in *Alpha* explains that meta-models cannot be modified by users (meaning the domain experts). There is a dedicated group of modellers working on meta-models. "Users can only use what they have" (Modeller in *Alpha*).

Second, a side effect of modelling is that the object-of-design becomes invisible when the access to models is not provided. To avoid this, there is a need to have different views of the model for different users. Especially AKM approach provides creating different perspectives to the same setting. "You can analyse context by context, but then you have a CEO that has an overview, that does not need to go in detail to know everything there, but he will need to extract information that is related to multidimensional space" (Modeller of *Alpha*). Of course there are problems of translating of representation of an activity from a model template to another.

Figure 6: Different views for different communities of practice.

Third, if modelling is chosen in an enterprise to represent organisational issues, then there is the danger of modelling everything like work practices, social relations, informal exchange between people etc. This is a problem because models have their limits. It is currently not possible to model certain informal exchange between team members, especially then when these are contingencies, are caused by unforeseen activities, results of improvisations, are situation-dependent etc.

Fourth, models normally enforce representing everything with boxes and arrows, modelling means usually translating into workflows. Workflows do not represent all

types of work practices. They normally are created top down, are predefined, well structured, logically and temporally well ordered. As mentioned before, there are several contingencies in workplaces and work practices which cannot be represented by workflows.

4. Conclusions

Our investigations resulted in several issues. We identified areas of change in organisational context, ways of articulation during decision making activities, how to use models as shared objects between participants and how to deal with limitations of access to models.

Models accommodate different types of conflicts by providing a flexible modification and simulation environment for users and modellers. They not only represent the conflicts, but they contain the agreement between cooperating communities of practice and unsolved issues as well.

Modelling facilitates articulation work by providing an externalised view of the world-to-model. This, on the one hand, depends how sophisticated the modelling tool is. Domain experts need to illustrate their view of artefacts and tasks connected to them to underline their concerns and wishes. This must be done in an ad-hoc manner. User configurability and usable access to modify the view easily are important requirements in this context. To enable articulation during modelling depends, on the other hand, on the skills of modellers and facilitators. Some modellers invite domain experts to participate in modelling, some unfortunately exclude them in certain matters. They use technical constraints as excuses for not being able to model the ideas of domain experts even if these were important ones. Sometimes listening to domain experts does not mean that modellers will implement what they were hearing.

Additionally we developed some questions for modellers and users to answer before starting modelling processes in an organisation, like:

- Where in the whole process do we start modelling?
- Which modelling approach is most appropriate for us?
- How can a document be decomposed into a model?
- What are the implications of migrating from static to a dynamic enterprise view?
- How can we manage the access rights to our models?
- How can we use templates to capture specificities of our organisation?
- How can we import and export data from and to a model?

There are still open issues we consider for further research like increasing meaningful participation of domain experts in modelling, design of modelling tools and methodological approach supporting involvement of related communities of practice.

5. Reference

Engels, G., Groenewegen, L., Object-Oriented Modelling: A Roadmap, in: ACM Computing Surveys, 2000, 105-116.

Curtis, B., Kellner, M.I., Over, J., Process Modelling, in: Communications of the ACM, 1992, 35, 75-90.

Jordan, B., Ethnographic workplace studies and CSCW, in: International Conference on the Design of Computer Supported Cooperative Work and Groupware Systems, Schärding, Austria 1993.

Kaindl, H., Carroll, J.M. Symbolic Modelling in Practice, in: Communications of the ACM, Vol. 42, 1999, 28-30.

Tellioğlu, H., Campagnolo, G.M., Jacucci, G., Use Context of Modelling in Model-Based Adaptive Product and Process Engineering, in: Proceedings of the Sixth International Conference on Computer Science and Information Technologies, CSIT 2007, September 24-28, Yerevan, Armenia, 287-291.