Supporting Collaborative Product Development through Automated Interpretation of Artifacts

Matheus Hauder[1], Sascha Roth[1], Florian Matthes[1], Armin Lau[2] and Heiko Matheis[2]
[1]*Lehrstuhl für Informatik 19 (sebis), Technische Universität München, Boltzmannstr. 3, 85748 Garching, Germany*
[2]*DITF Denkendorf, Centre for Management Research, Koerschtalstr. 26, 73770 Denkendorf, Germany*
{*matheus.hauder,roth,matthes*}*@tum.de*, {*armin.lau, heiko.matheis*}*@ditf-mr-denkendorf.de*

Keywords: Product Development, Collaboration Model, Business Modeling, Business Process Coordination.

Abstract: Small and medium-sized enterprises collaborate with partners to develop highly innovative and knowledge-intensive products. Collaboration models describe in detail how this goal can be achieved. These models can be supported by an implemented and executable version thereof. This paper describes an implementation of a collaboration model from the European research project SmartNets using an automated interpretation of artifacts. We explain the collaboration model, describe the implementation and evaluate our proposed solution by means of an example from one of the projects industrial networks.

1 INTRODUCTION

Increasing complexity of products and processes, condensed product life-cycles, quickly changing market requirements and globalized competition are major challenges that companies, and in particular European small and medium-sized enterprises (SMEs), have to face. The key to mastering these challenges is an effective and efficient development, production and marketing of new products, processes, and services. For many SMEs, due to their limited availability of resources and their concentration on core competences and niche markets, it is very difficult to elaborate such innovations from the idea to the final product completely on their own. Therefore, more and more, SMEs collaborate with trusted partners in loosely coupled development networks to combine their knowledge and resources and to share the associated risks (Mazzarol and Reboud, 2008). Even though there are several examples of success, the lack of appropriate methods and tools to support conjoint innovation within networks is still hampering the effectivity and efficiency of such collaboration (Dooley and O'Sullivan, 2007). The objective of the European research project SmartNet is to develop and to evaluate methods and tools supporting collaborative development and production networks in the product development, in network coordination and in the transformation from development to production[1]. For that, SmartNet follows the concept of the smart organization (Filos, 2006).

[1]https://www.smart-nets.eu/, last accessed Dec. 6, 2012

Social software solutions as information and communication technologies could play a crucial role as enabler for collaboration in future. They support the conjoint documentation, exchange and elaboration of information, and with the help of appropriate ICT systems, process models can be implemented and enacted, promoting and supporting the use of these processes in the daily work. Although social software provides manifold possibilities for a better support of these challenges, current research is mainly focused on the use of social software for advertising and marketing purposes (van Osch and Coursaris, 2013). We argue that social software can be used to endorse a better support for collaborative product development.

In the following, the SmartNet Collaboration Model, a model for collaboration in development and production networks developed in the course of SmartNet will be introduced. It will be demonstrated how the model has been implemented on the projects collaboration platform Tricia. Special attention will be given to the SmartNet Navigator, a tool to assess the process status of a development project. This processes status is automatically computed with an own substitution language that is utilized to present the current progress of the involved artifacts in an interactive visualization. Its application in collaborative product development will be evaluated with an example from a project dealing with the conjoint development of an innovative motorcycle helmet.

Hauder M., Roth S., Matthes F., Lau A. and Matheis H.
Supporting Collaborative Product Development through Automated Interpretation of Artifacts.
DOI: 10.5220/0004774901510156
In *Proceedings of the Third International Symposium on Business Modeling and Software Design (BMSD 2013)*, pages 151-156
ISBN: 978-989-8565-56-3

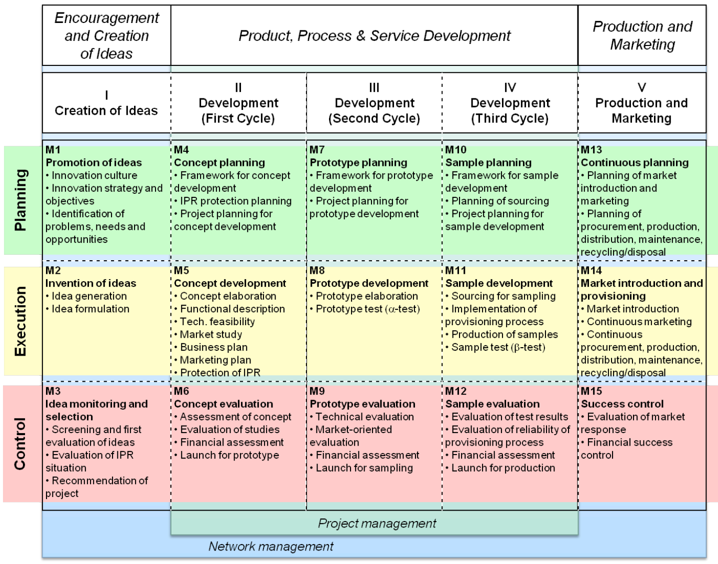

Figure 1: Reference process - key element of the SmartNet Collaboration Model (Lau et al., 2012).

2 SMARTNET COLLABORATION MODEL

In the operative planning, execution and control of collaborative innovation activities, there are several questions, which will continuously come up throughout the development. Six generalized key questions have been identified which will emerge in one or another form (Lau et al., 2009):

- *What* do I have to do, and when shall I do it?
- *How* can it be done?
- *Who* can do it?
- *How* can I do what, and when?
- *What* shall I do when and with whom?
- *How* can I collaborate with whom?

The SmartNet Collaboration Model provides answers to these questions by connecting three key elements of collaborative development: process model for development and production, internal and external actors, innovation management methods and techniques (Lau et al., 2009). Each element is described in detail with numerous instances, e.g. with a list of roughly eighty actual methods and forty-eight process activities. Figure 1 shows the complete reference process, to which we will refer later on when discussing the particular part of the SmartNet Navigator.

The relations between these three elements will be attributed with values indicating support potential, i.e. for which step in the process, which kind of actor is best suited to be involved (Lau et al., 2012). A dedicated processing model is provided which explains how these structures can be applied in the practice of collaborative networks (Lau, 2012).

2.1 Implementation of the Model on a Collaboration Platform

We implemented the above-described collaborative process utilizing the Hybrid Wiki extension (cf. e.g. (Matthes et al., 2011)) of the Enterprise 2.0 platform Tricia. Hybrid Wikis are based on a non-rigid typed system. They allow users to alter respective models at runtime by modifying the contained data on which it is based. Attributes and entities can be added or removed by end-users in such an intuitive manner that the actual process of modeling, steps into the background and users are first and foremost concerned about their data (data first, schema second).

2.1.1 Tricia - Hybrid Wiki for Enterprise Collaboration

With Hybrid Wikis, collaborative work that is commonly based on a model in particular can profit from the lightweight modeling approach. Hybrid Wikis do not require a special syntax for modeling or contributing data, i.e. everyone may add and manage information/knowledge, which is commonly referred to as crowd sourcing. Besides the typical unstructured content, a Hybrid Wiki page also includes structured content consisting of key value pairs (e.g. management activity type and process phase in Figure 2). By default, an attribute added by an end-user is of the type string.

The type can also be assigned to a value explicitly, which can be regarded as the schema definition. A small icon appears to indicate that this is a type defined by a so-called type definition. The actual type assignment of a wiki page is as simple as adding ordinary tags to a web 2.0 page. By assigning such a Type Tag, the type definition refers to this concept (here: activity type). In such a definition, each attribute may be assigned a type, i.e. string, number, date, enumeration, or a link to another page. In the latter case, also the type of the target page can be specified. With these type definitions, Hybrid Wikis cover the range from not at all typed to strictly typed (mandatory attributes with cardinalities) meta-models as in common relational database systems. Once defined, the type definition is applied to all instances of this type of pages.

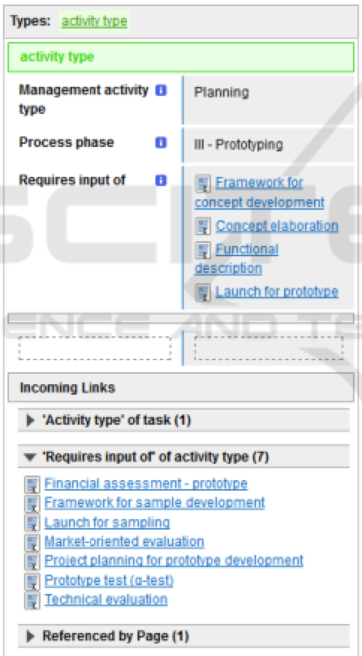

Figure 2: Attributes of the activity type.

2.1.2 Elements of the Collaboration Platform on Tricia

For the implementation of the SmartNet Collaboration Model the extended functionalities of Hybrid Wikis are essential. These above described functionalities enable a contextualization of simple pages to combine textual descriptions of process activities, methods and actors and relations between these entities. The implementation of the collaboration model was started with the reference process in Figure 1 because of its guideline characteristic. Every single activity that is mentioned in this process is implemented as a page of a special type, which is called *activity type*. All activity types consist at least of an explanation on what this activity is about and its position in the reference process. The position in the reference process is described by the process phase to which an activity belongs and by its management activity type from other activity types to identify possible previous steps in the process. Accordingly, reverse relations that can be found under *Incoming Links* in Figure 2 point out potential following steps. The storage of that information enables the implementation of a kind of workflow to suggest possible next steps on the basis which activity types were already finished. This kind of structuring allows adapting the reference process very flexibly to specific needs of different fields of application. Due to the fact that these activity types are one of the key elements of the collaboration model these adaptations affect all other derived tools like the SmartNet Navigator, which is deeply related to the reference process. The second element of the collaboration model, which is already implemented on Tricia, is a methodology to support the development and the collaboration in the networks. In a first step, around eighty methods - suitable for the application in enterprise networks and across companys borders - were identified and described on the project platform. These descriptions consist of basic information about the methods with strengths and weaknesses and application guidelines to support the project partner in implementing the methods into their development projects. Also actors are implemented in a similar approach as type tag with various attributes, identifying mostly their positioning in the supply chain. By this, it will be possible to extract information about actors from models of the network topology of the project networks. Finally, the relations between the key elements of the collaboration model were built. For that, more information is required. For example, to describe methods sufficiently, it is necessary to identify:

- Which results can be reached by applying the methods,
- The activity types for which the methods are suitable, and
- Their contribution to knowledge management, including required and created knowledge.

All this information was documented using the hybrid attributes of the Tricia system either by building relations to other information (e.g. for the different degrees of suitability), using prepared enumerations (e.g. to categorize the method type and the build-

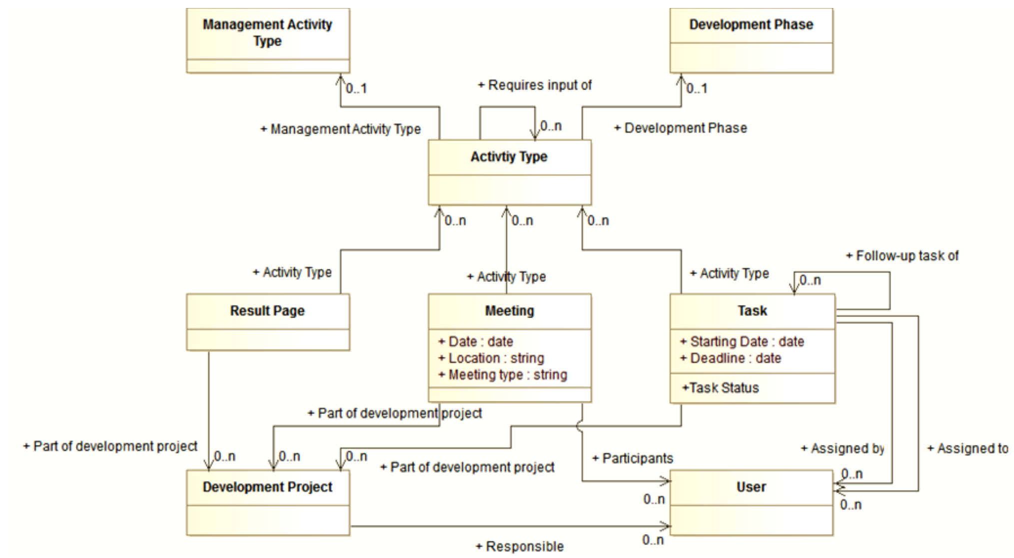

Figure 3: Meta-model of the described SmartNet collaboration model.

ing blocks of knowledge management (Probst et al., 1998)) or normal text (e.g. to specify input and output knowledge). By using all this data it will be possible to answer the six key questions presented in Section 2 in future.

2.1.3 SmartNet Navigator - Tool for Automated Status Analysis

The automated status analysis is performed using a substitution language developed within the Hybrid Wiki project that can be used to query the data (attributes) of the collaboration model. Their computation is based upon a meta-model that is shown in Figure 3. The collaboration model consists of several meetings that are part of a development project. Meetings can contain activity types that might require preceding activities as input. They can also be related with a management activity type, e.g. project management, network management, and a development phase, e.g., production and marketing.

An example instance for an activity type is shown in Figure 2. Result pages are used to document the findings from different activity types in a development project. Activity types also contain tasks that are assigned to respectively by users. Every task contains a *starting date* and a *deadline* until the task has to be finished. The progress of the status is tracked with an attribute *task status*. In addition, a development project can have several users who are responsible for the project.

Figure 4 shows an example for the computation of states for the process phase. Variable *allStati* is computed containing all states from a particular process phase by selecting all *activitiy types* from this phase. The state of an activity is retrieved with a function called *statusOfActivityType*. In the second variable valid combinations for the visualizations of the resulting state are stored. Only in case both values are finalized (or open) the aggregated value is finalized (or in-progress). In case the variable *allStati* is empty, the process phase is regarded as finalized. Alternatively, the variable is not empty and a higher-order function is used to compute the aggregated value of all containing activities.

3 PRACTICAL APPLICATION

The SmartNet Navigator is applied in all three industrial networks of the SmartNet Project. From the beginning of the project all partners started documenting their development activities such as meetings and tasks by using the Tricia platform. Using the possibilities of the hybrid attributes, provided by the platform, enables the industrial partners to extend the basic information with additional data as for instance starting date and deadline for tasks and participants and location for meetings. In addition to this very content specific information they related all their development activities on the one hand to certain development projects and on the other hand to activity types.

The following chapters give an exemplary view of the situation in one of the industrial networks with a short description of the network and the targeted product and the realization of the SmartNet Navigator.

```
statusOfProcessPhase

let allStati = find("activity type", "Process phase", ph)
  .select(?(at) (this.statusOfActivityType(at))) in

let combine = ?(s1,s2) (
   s1.equals("finalized").and(s2.equals("finalized")) ? "finalized"
      : s1.equals("open").and(s2.equals("open")) ? "open" : "in-progress") in

allStati.isEmpty() ? "finalized" :
allStati.aggregate(combine, allStati.first())
```

Figure 4: Code listing computing states of the process phase executed when loading the SmartNavigator.

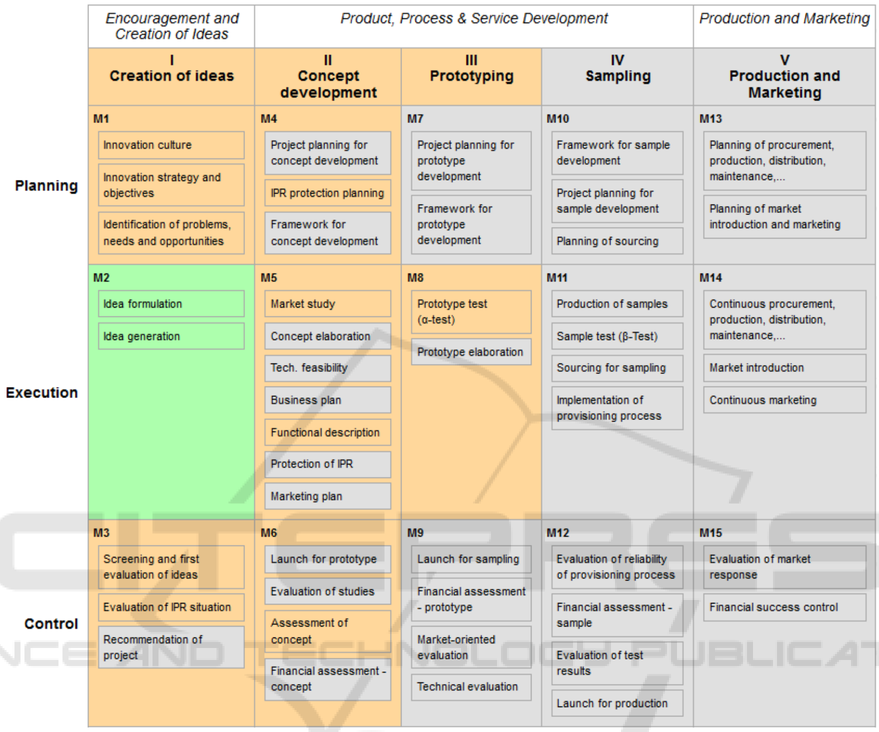

Figure 5: The SmartNet Navigator of the Innovative Helmet Network with an automated interpretation of artifacts.

3.1 Introduction to the Innovative Helmet Network

The Innovative Helmet Network (IHN) mainly consists of three SMEs that are supported by a research organization and a consultancy. Together they are developing a new motorcycle helmet, which will be made out of completely new materials with special properties. This new helmet will reach a new level in protection and will give more freedom to the designer especially in shape and size. Besides the development of this new helmet, the network also develops new production technologies and processes to increase the effect of the new material.

To handle the arising challenges, the core of the network consists of a chemical company which is responsible for the development of the material and its processing, a product engineering and manufacturing company which has a lot of experience in the development and production of protection gears for different fields of application and which will be the manufacturer of the final helmet.

The third partner in the network is an engineering consultancy with main focus on technical design, which supports both other partners and coordinates the collaboration during the development phases. Both associated partners support the network in general issues, e.g., management and protection of intellectual property rights (IPRs), the application of innovation management methods and the SmartNet Collaboration Model.

3.2 SmartNet Navigator Supporting the Development Network

Product development is a complex and challenging topic in particular in networks of several enterprises. In this network context the enterprises need some space where they are able to collaborate, share knowledge and information, document and coordinate their work with each other. For this specific network that participates in the SmartNet Project the partners use the project collaboration platform 'Tricia' to face all these issues.

Typically for the industry sectors, documentation will only be done if it is either recommended or required due to quality or risk assurance or the enterprises really can benefit from it. Thus, the SmartNet Navigator has to consolidate the documentation of all development activities to show the current status of the collaborative development project. This automatically interpreted status supports the coordination of the collaborative product development project.

For the IHN this means that all meetings, tasks and results that were documented on the project platform are related to activity types and to the development project they contribute to. Based on the rules exemplarily described in Section 2.1.3 the SmartNet Navigator application calculates the current status of the development project and visualizes (cf. e.g. (Hauder et al., 2012)) the result as shown in Figure 5.

This example shows that the IHN has collected and formulated their ideas (M2 is finalized; colored green) on how this new motorcycling helmet should protect its bearer. They are currently working on the processing of the new material to set up several prototypes of the complete helmet. Parts of it like the inner shell have already been tested against the homologation criteria (see Prototype test (α-test) in Figure 5).

Obviously, the SmartNet Navigator in Figure 5 reveals several open (grey) or in-progress (orange) modules and activity types owing to insufficient documentation or switching between several activities and forgetting to finalize or start them. In both cases the SmartNet Navigator reminds the team on the one hand to finalize the activities and on the other hand to collect all information they may need in later activities when it is easy to get them. A second big advantage for the network or single decision makers is to get a quick overview on the current status of the development.

4 CONCLUSIONS

The SmartNet Navigator helps enterprises acting in collaborative networks to identify states of development projects. Network partners highly esteemed this aggregated view, as it gives a good overview at a single glance and serves as a nice instrument to evaluate the information basis. The information about the current state will be used for further implementation of tools supporting the application of the collaboration model itself, e.g. by using the information to propose methods and techniques of innovation management to the users or to recommend network partners.

REFERENCES

Dooley, L. and O'Sullivan, D. (2007). Managing within distributed innovation networks. *International Journal of Innovation Management (ijim)*, 11(03):397–416.

Filos, E. (2006). Smart organizations in the digital age. *Integration of Information and Communication Technologies in Smart Organizations. Idea Group Publishing, Hershey*, pages 1–38.

Hauder, M., Matthes, F., Roth, S., and Schulz, C. (2012). Generating dynamic cross-organizational process visualizations through abstract view model pattern matching. *Architecture Modeling for Future Internet enabled Enterprise*.

Lau, A. (2012). *Methodisch-technologische Unterstützung kollaborativer Innovationsprozesse in Smart Networks*. Verlag Dr. Hut.

Lau, A., Fischer, T., Hirsch, M., and Matheis, H. (2012). Smartnet collaboration model-a framework for collaborative development and production. In *Engineering, Technology and Innovation (ICE), 2012 18th International ICE Conference on*, pages 1–10. IEEE.

Lau, A., Fischer, T., Rehm, S.-V., and Hirsch, M. (2009). Collaborative innovation in smart networks–a methods perspective. In *2009) Proceedings of the 15th International Conference on Concurrent Enterprising: ICE*.

Matthes, F., Neubert, C., and Steinhoff, A. (2011). Hybrid wikis: Empowering users to collaboratively structure information. In *6th International Conference on Software and Data Technologies (ICSOFT)*.

Mazzarol, T. and Reboud, S. (2008). The role of complementary actors in the development of innovation in small firms. *International Journal of Innovation Management (ijim)*, 12(02):223–253.

Probst, G., Raub, S., and Romhardt, K. (1998). *Wissen managen: wie Unternehmen ihre wertvollste Ressource optimal nutzen.*, volume 2. Aufl. Gabler, Wiesbaden.

van Osch, W. and Coursaris, C. K. (2013). Organizational social media: A comprehensive framework and research agenda. *Hawaii International Conference on System Sciences HICSS 46*.