A case-study of wiki-supported collaborative drafting of business processes models

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***Abstract*—Redesign of business processes is an activity frequently performed in modern organizations as a response to intrinsic and extrinsic change requirements. The way (methods, techniques, tools) a process is redesigned varies greatly with the process context. In contrast, involving stakeholders of a process in process redesign can be considered a common practice throughout organizations of all kinds. Hence, research and industry have only recently investigated the characteristics of collaboration in process redesign and the challenges that arise for software-support respectively. In this paper we will systematically describe findings from a case-study where we adapted a particular type of collaboration technology – a wiki engine – towards collaborative process modeling support and exposed it to a real-world setting. The case-study shows how a small team of domain experts within a large office supply manufacturing company redesigned a recruiting process by using a wiki as their primary process modeling environment.**

***Keywords*-information systems design; business process design; business process modeling; collaborative modeling;**

I. Introduction

Designing new and redesigning existing business processes as a response to intrinsically and extrinsically motivated change is frequently practiced in modern organizations. For such organizational change projects stakeholders are usually involved at some stage. This has been early recognized as beneficial for the overall effectiveness of process redesign efforts [1]. During such projects business process models usually serve two purposes: as an analytical means for capturing and understanding the process and as a means to communicate and share results among stakeholders of a process redesign effort [2]. Typically, the creation of business process models is performed by experts that are literate in a modeling method and related software tools. Although a modeling expert is in continuous interaction the creation of a process model is generally locked away from other stakeholders in the process. This partially grounded in the fact that the focus in business process modeling has been traditionally on the final artifact rather than on the process of modeling. In other words, the genesis of a process model – the iterations, related design decisions and communicative acts that lead to a particular process design – has been largely neglected both from a methodological and a software-support point of view. This in turn led to closed expert systems that enabled only limited participation, involvement and collaboration of diverse stakeholders in the process of model creation.

To overcome the above outlined drawbacks of traditional approaches, also the business process management community has recently discovered potential applications of social software [3], [4]. A class of social software that has gained increasing interest in research and practice [5] are wikis. Since Wikipedia – as it's most popular application – has been launched in 2001 [6] a plethora of wiki engines are available either as open-source or commercial software. Wikis have been included by major software producers in their product portfolios (e.g. Microsoft Sharepoint, Lotus Notes) and therefore have found their way as well into organizations of all kind. Although a large variety of wiki software exists to date a common characteristic of wiki engines is that they are designed to support quick and informal collaboration [7] in knowledge acquisition, externalization and structuring [8]. It is for the before mentioned characteristics of wiki engines that makes them a interesting both on a paradigmatic level – shift from closed to open modeling environments – and on a technological level. In recent years several conceptual studies (e.g. [9]–[11]) of wiki engines to support process modeling have shown promising results towards practical applications. However, to gain evidence of their practical relevance also studies in real-world contexts need to be provided.

In the following (section II) we will give a short outline of the characteristics process modeling with regard to inherent social interactions. Subsequently (section III), we outline how we adapted a particular type of collaboration technology – a wiki engine – to the specific requirements of collaboration in early process modeling stages and which major design decisions were made. The major part of this paper (section IV) is dedicated to the presentation of results from a study of wiki use in a real-world organization context. Namely, an industrial setting where a small group of people were engaged in a process redesign activity over a period of six months.

II. Process modeling as a social activity

Modeling in general sense can be regarded as a process consisting of four main activities : (1) Elicitation, (2) Modeling, (3) Validation, (4) Verification [12]. *Elicitation* refers to the act of collecting information from domain experts, it's verbalization into an initial specification and further reformulation into a informal specification. *Modeling* is targeted at the transformation of the informal specification

Presented at IEEE Conference on Business Informatics (CBI), Vienna, July 15th, 2013

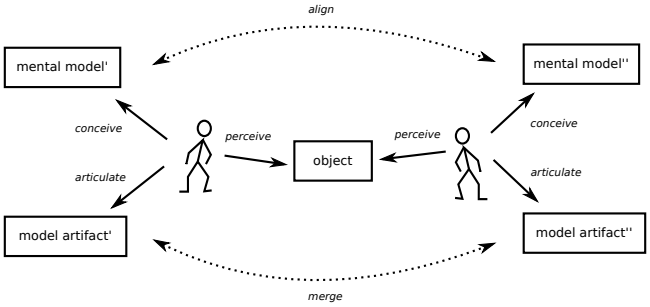

Figure 1. The act of collaborative modeling after [13]–[15].

into a formal specification that comprises a conceptual model along with grammar rules, constraints and a lexicon. The formal expression of an informal domain description is reached through identifying relevant domain concepts and their relations (grammatical analysis) and mapping concepts to model language specific concepts. Validation refers to the act of evaluating the congruence of the formal specification with the informal specification. This stage model outlines that a modeling activity involves both the informal world of the domain expert who uses natural language to express statements about a universe of discourse and the formal world of the system analyst who uses formal language [12]. Each of the two roles own a specific set of competencies and skills that is needed during the modeling process and is the reason for social interactions. The informal specification or dialogue document is used as a link between the two worlds and can be regarded as the result of a dialogue between the modeler and the domain expert.

The act of modeling can further be decomposed into several fundamental processes [13]. Accordingly, modeling is composed of three basic actions: (1) perceiving, (2) conceiving, (3) representing. Perceiving refers to the act of transferring observations of a "real-world" object into a mental representation. Conceiving refers to the act of interpreting a mental representation into a mental model. Representing is the act of articulating a mental model, that is the explication of mental model by means of a language. A fundamental assumption in this concept of modeling is that mental models of reality need prior articulation to be communicated and discussed with other observers.

Proper et al. [13] refer to the fact that different people most likely have different perceptions of a "real-world" object (e.g. a business process) and most likely develop different mental models of their perceptions. In their theory of modeling this divergence in perception and model conception is at least strongly influenced by the meta-model an individual is used to employ (or trained/enforced to use). In [16] argue that each individual has it's particular conception of the object under focus. The only way individuals can achieve a commonly agreed model of a domain or object of interest is to communicate with each other, remember and build upon what has been discussed in an incremental way. Therefore modeling can be conceptualized as a dialogue between a number of individuals towards a common goal [16]. With regard to the roles individuals take or make in the course of a collaborative modeling effort three types of involvement can be distinguished: informing, mediating and deciding. Whereas the latter two refer to the knowledge transfer part of collaborative modeling the first one refers to the fact that some issues need an individual with the decisive power to resolve such issues [17].

The notion of breakdowns in the context of collaborative process modeling has been introduced by Hahn et al. [18]. Accordingly, breakdowns are unexpected disruptions of the modeling process. Based on an experimental study they have identified breakdowns on the three levels of the semiotic ladder. On the pragmatic level – which refers to communication, organization and tool handling, tool deficiencies – almost two thirds of all disruptions occurred where most of the disruptions were related to the tool. Almost another third of all disruptions occurred on the semantic level (process decomposition, concept mapping, rescoping, deletions) whereas on the syntactic level only a minor number of breakdowns were observed.

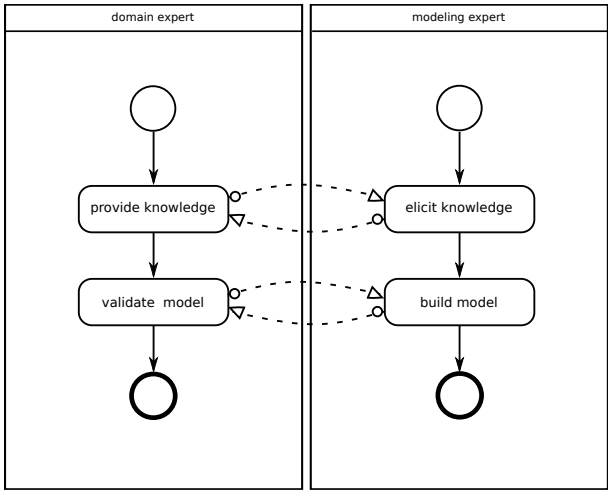

Figure 2. Basic role interactions during process modeling

From the above review of prior research and our own investigations of process modeling practice [19] we have learned that the activity of collaborative process modeling can be conceptualized as the set of emergent (communicative and creative) and non-emergent (cognitive) actions that are performed by a group of individuals with the goal of creating a set of process model artifacts. It is assumed that knowledge about the process to be modeled already exists in some form (tacit mental model or explicit process description) and serves as an input for the creation of a process model. A collaborative process modeling activity involves both domain (process) experts and modeling experts

that jointly transform a conceptual model into a more or less formal process model and produce a tangible process model artifact. Social interactions between the different types of stakeholders are inherent to reach consensus about different perceptions of a real-world process and the subsequent creation of a respective model artifact.

III. *xoProcessWiki* – A WIKI FOR COLLABORATIVE PROCESS MODELING SUPPORT

For our case-studies of a wiki-supported drafting of process models we have designed *xoProcessWiki*, a wiki engine that was especially developed to support collaboration in process model building. *xoProcessWiki* is based on *xoWiki* a wiki engine that is part of a freely available open-source community platform development framework (see [20], [21]) and was primarily developed to support textual content. The decision for *xoWiki* as the base engine was mainly grounded in the fact that is an extensible framework, where one wiki page can contain fields of different types such we could add a new field type for business process models. Created pages and fields can be changed and extended on the fly due to the underlying dynamic language framework [22], [23]. Furthermore, it is an open source framework that is used within the university's eLearning system [24] and various other application domains by a rather large community of developers around the world. *xoWiki* provides typical wiki functionality along with some unique features that are vital for wiki applications in business domains, e.g. fine-grained user authorization and workflow support.

xoProcessWiki as an extension of *xoWiki* has inherited several fundamental features for collaboration support. However, a major challenge arose when we strived to support the specificities of process models as a particular type of content. In the following a brief outline of the most relevant features for collaboration support is provided. We grouped these features regarding the above outlined classes of activities, namely activities primarily targeted at (co-)creation of models and activities primarily targeted at communication.

A. Features for model co-creation.

In *xoProcessWiki* all types of content are handled in the context of a page object. To define a content type specific application behavior for rendering, validation and storing page types can be defined. These page types are as well used to implement a content specific user interface (e.g. a form). We have used this mechanism to satisfies the requirements of process models as a specific type of content. In particular, we have designed a page type that allows to specify meta data (e.g. a process name, a process category, and a process responsible) along with a textual description and as well a diagramming interface that allows to specify the behavior of a process according to notations like BPMN or EPCs. By allowing both informal textual descriptions and semi-formal process specifications both expert modelers and stakeholders without modeling expertise are enabled to participate and contribute in all phases of modeling.

Linking allows not only to link process model pages but as well allows for the intentional creation of so called "dead" links that mark those points of a process model description that needs to be further detailed. The decomposition of process models into submodels and respective links facilitates reuse of process models in other contexts. Both incoming and outgoing links are automatically recognized and support users in navigating between interlinked (parts of) process models.

Tagging of process models can be accomplished by adding tags that follow individual preferences which enables a user to build a personalized taxonomy. In addition a user may reuse existing taxonomies from other users. Together with a full-text search engine pages may be easily retrieved and therefore reused, extended or changed in the course of collaborative model building.

Revisions of a process model are recorded and can be retrieved via a page's revision history. In the context of collaboration revisions are a means to avoid disruptions of work caused by unintentional or unreflected changes to an object. Revisions help users to resume prior work without the fear of data loss. Revisions support a group of users in keeping track of who changed or contributed what in the course of a collaboration. Additionally, the revision history together with the communication log (see next section) enables recalling of design decisions at a later point of time.

Concurrent changes are handled through the implementation of a respective mechanism. This mechanism compares concurrent revisions supports users in merging concurrent changes changes and manual resolution of conflicts through an adequate user-interface component.

B. Features for communication.

A simple yet useful feature to create awareness of other parties currently present on a collaboration platform is the "who's online" feature. It reveals the group of people that is currently logged in at the wiki. This feature has been supplemented with a more fine grained indicator widget that informs about who is currently changing which part of a process model. A user viewing a process model therefore is not only aware of the presence of other users but as well which parts of a process model are currently worked on.

Comments are a way to invite users to participate in a collaborative effort without the need to actively get involved in the creation and editing of a content object. By simply leaving message like annotations to a content object users can propose improvements and may effectively point to deficiencies. Through inline annotations users may as well leave personal notes within a process diagram to signal a disagreement or simply indicate parts of a process model that need further attention.

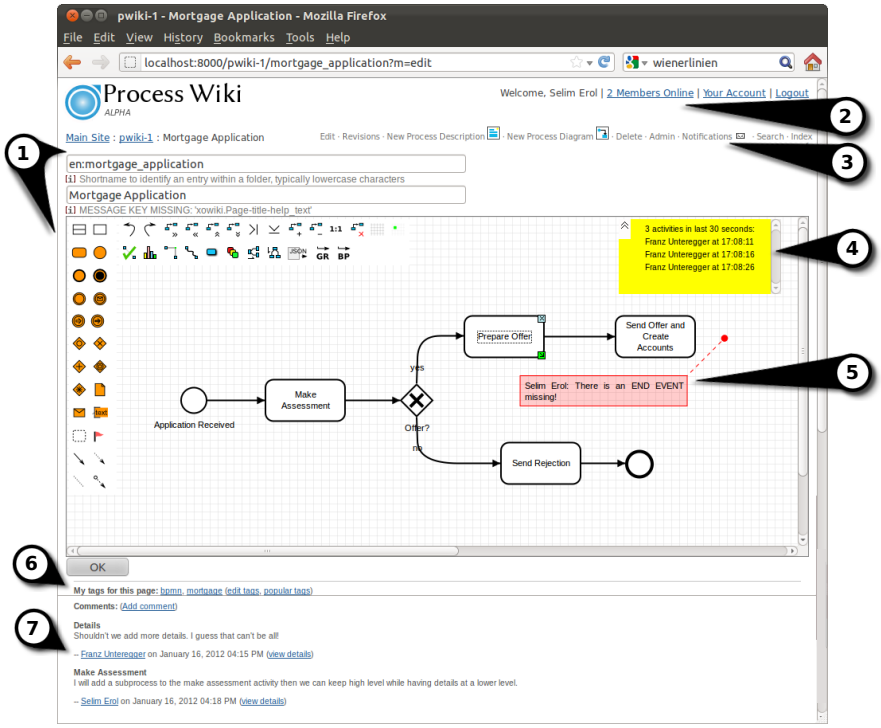

Figure 3. *xoProcessWiki* features: (1) form editor and diagrm editor component, (2) who's online, (3) notifications, (4) activity indicator, (5) inline annotations, (6) page tagging, (7) page comments

The above described features represent only a limited outline of *xoProcessWiki* features that we considered most relevant for the requirements of collaboration support as mentioned in section II and to provide a background to the collaboration software used for the case-studies which are described in the next section.

IV. Experiences from Case-Study

The case study described in this section followed two goals. First, the wiki-based collaborative modeling environment (*xoProcessWiki*) described above is evaluated by studying it's adoption and use in the field. Studying the practical use of *xoProcessWiki* in a real-world context led to valuable feedback and requirements for the further development. Second, the case-study was intended to explore the characteristics of wiki-supported collaborative process modeling in general which in turn provided practical insights about the social processes involved in process modeling. The case-study is described by a short outline of the organizational context and setting and a qualitative description of the modeling process. Subsequently the data collected through interviews and log files is analyzed and interpreted.

xoProcessWiki as the modeling environment supporting the collaboration between the participants was made available through a dedicated web server. A "blank" instance of xoProcessWiki was created that was used exclusively for this case-study. In a separate wiki instance a large body of training resources have been made available including tutorials, example process models, and links to external resources. The *xoProcessWiki* instance was configured in a way that did not allow for participation without registration and authentication. This configuration was necessary to meet confidentiality requirements of the process models and to enable the analysis of individual activity in the wiki.

A. Organizational context

The case-study was conducted in the Hungarian subsidiary of a large European manufacturer and distributor of office supplies with headquarters in Switzerland. The product portfolio of the whole group can be divided into four product groups: standard office products, corporate (customized) office products, school products and time management products. The Hungarian subsidiary is primarily concerned with production, the distribution of products is carried out by other sister subsidiaries. The subsidiary produces more than 500 products and employs about 200 employees.

Due to an expansion of production capacities in the last years the subsidiary had to cope with an increased need of personnel in production and administration. The increased need in personnel led to a re-organization of the recruitment department. For this purpose the assistant to the chief executive officer (CEO) was asked to re-design and standardize the actual recruitment process. The recruitment department – at the time of the case-study – comprised five

employees.

Stakeholders involved in the re-design effort were the assistant of the chief executive officer (abbreviated as *VV*), the head of the HR department (*OS*), one of the authors as external expert (*SE*), the CEO of the company and the head of production. However, only the first three (VV, OS, SE) were actively involved in model construction. Participant VV was mainly occupied with the analysis of the "as-is" process, and the drafting of the "to-be" process. Participant OS as the head of the HR department was responsible for validation of the "to-be" process, She also contributed her knowledge of the actual recruitment process. The head of production served as a process expert and provided his profound process knowledge. The CEO of the company mainly defined the goals for the "to-be process" and was recurrently consulted for decisions regarding the project. Participant SE (the author) acted as an external expert in the creation of process models and helped with the formal validation of process models. During the re-design of the process and especially after finalization process models have been presented to a wider group of process participants not actively involved in the deign but concerned with the operational aspects of the process.

B. Findings

Collection of data is mainly based on personal observation, a qualitative interview and data collected from the respective wiki instance. As the group involved is relatively small (a scenario that is quite often encountered in practice) only one interview was conducted with VV who was mainly responsible for process re-design and the introduction of the *xoProcessWiki* within the organization. The interview was conducted in an informal way by posing several questions regarding the background of the re-design project, the procedure followed and the subjective experiences from using *xoProcessWiki* with regard to effectiveness and efficiency. The findings from the interview are summarized below:

- The re-design process was initiated by a so called "kick-off" meeting where the main goals of the re-design project were defined and the "as-is" process was discussed and analyzed. In the initial meeting all participants (as mentioned above) were present providing their operational and managerial expertise. The output of the first meeting was a common understanding of the actual recruiting process and an outline of the goals of the re-design project. *xoProcessWiki* was not involved in this stage of the project.
- Before starting to create models of the processes VV introduced herself to the modeling notation to be used. Therefore she consulted a book, but mainly studied the numerous example process models provided in the wiki instance. In a next step she started with a preliminary model to make herself familiar with *xoProcessWiki*. VV pointed out that the Search feature was of particular usefulness in the beginning of her modeling as it allowed for rediscovery of previously created models and examples.
- In the next step VV summarized the findings of the "kick-off" meeting by developing an "as-is" model of the process. This step was followed by the design of a preliminary process model version in *xoProcessWiki*. These steps were accompanied by several interviews and meetings with stakeholders to capture more detailed information on the future process. VV mentioned that in a first attempt she created one process model to capture all aspects and sub-processes of the future process.
- Subsequently, she partitioned the model into sub-models by using the linking feature. Hence, VV pointed to the fact that the linking syntax was quite unusual to her in the beginning and although she quickly get used to it she would recommend a simplification of the linking feature. VV perceived this feature as a major benefit of *xoProcessWiki* which is especially useful when the model size increases.
- After the completion of the first version of the process models SE used the commentary feature to give feedback on the formal validity of the process models. The formal validation process comprised two steps: first, the structural integrity of the models was analyzed. It turned out thatd with quite a lot of elements appeared unconnected. Second, the models were checked with regard to their syntax and semantics. The errors discovered were added as comments. The interview with VV revealed positioning and connecting elements appeared to be difficult. Especially, the geometric adjustment of edge shapes was perceived rather difficult. Later VV read the comments and altered the models according to the comments.
- As soon as the process models reached a mature state the process model of the future recruiting process was presented as a whole to the process participants to receive feedback and possible suggestions for improvements. It is important to note that for the presentation purpose the models from the wiki where copied into a document (a Microsoft PowerPoint presentation). VV argued that this was perceived better suitable for the people not concerned with modeling and allowed for the organization of models according to the structure of the presentation. VV pointed to the fact that it would be desirable to have a printing feature to print out models only without any surrounding page details.
- The feedback gathered from the presentation was incorporated in the wiki and finally was released to the overall process responsible (OS) for the final approval. For this purpose the process responsible was informed via an e-mail including the link to the wiki instance. She was asked to submit her final remarks via the commentary function in *xoProcessWiki*. The final sug-

Table I
BASIC METRICS FOR THE WIKI INSTANCE

Metric	Value
Number of users	3
Users involved in page revisions	2
Users involved in page comments	3
Period in days	132
Days of activity	11
Pages created	36
Comments added	24
Revisions of pages	191
Contributions (revisions+comments)	215
Comments/page	0.67
Revisions/page	5.31
Contributions/page	5.97
Pages/user	12.00
Comments/user	8.00
Revisions/user	63.67
Contributions/user	71.67
Pages/day	0.36
Non-empty pages/day	0.72
Comments/day	0.18
Revisions/day	1.45
Contributions/day	1.63

gestions were included into the model and then the model was considered complete.

- VV argued that textual descriptions of process models are beneficial to facilitate the instruction of new process participants. Here, *xoProcessWiki*'s feature for creating as well textual descriptions of process models is considered a major benefit. Process model diagrams from *xoProcessWiki* will be as well included into a process handbook which will be circulated within the whole group.
- As VV considerd the model of the recruiting process as complete for the purpose of enacting a new process. However, it is highly probable that corrections to the models will be necessary in the future. The wiki is expected to facilitate model maintenance due to it's easy accessibility and the possibility to keep track of changes. Asked whether she would recommend to use *xoProcessWiki* for further projects she admitted that for complex process models with a large number of sub-process models she would prefer *xoProcessWiki*.

In addition to the interview data the wiki instance's log files and database that stores the page content, revision history of each page and user related session data have been analyzed. The data were analyzed regarding the quantities and qualities of collaborative model creation. The analysis was performed from two points of view: a cumulative view were contributions and activities to the wiki instance are measured in total, and a time-line view where activity related data and their characteristics were investigated over time.

As table I reveals, only a small group of three users was actively involved in the wiki. The number of users refers to users having either contributed a revision to a page or having added a comment to a page. The number of users does not include those users that participated passively by viewing pages of the wiki instance. Hence, the wiki's log files reveal that at least six visitors (257 visits) have viewed the index page of the wiki instance, and that a minimum of four visitors (59 visits) have been counted for the page containing the top level process model. A total of 3572 views of wiki pages have been counted. The visitor statistics rely on the identification of a visitor by it's unique user number. Anonymous users (those users that have not identified themselves by providing their user name and password) are summarized as one user. Therefore the actual number of visitors cannot be determined. Table I reveals as well that the three users involved in model contributions worked on the models over a timespan of more than four months (132 days). In this period forty-eight (48) pages have been created of which twelve (12) pages have been found to contain no content. These empty pages are due to the fact that in *xoWiki* for any newly created page a page stub is created even if it has never explicitly been saved by the user. The creation of empty pages mainly have occurred in the starting phase of the modeling effort. In the overall timespan of 132 days only on eleven (11) days actual contributions were recorded.

To gain insight into the collaboration of users with regard to process models the relations between users and wiki pages (process models) were analyzed by using techniques from the field of social network analysis. Namely, collaborations between users were conceptualized as two-mode networks [25]. The term "mode" refers to the classes of entities which are represented as nodes or vertices within a graph. Typically, a two-mode network allows only relations between nodes from different entity classes. In our case-study the users form one class of entities and the process models (pages) form the other class of entities. From the data given it was only possible to derive relations between users and pages through their revision history and the comments added. Figure 4 shows a visualization of user contributions to the wiki instance as a two-mode network: rectangular nodes represent process model pages, circular nodes represent users (user ids), edge widths represent frequency of user contributions (revisions, comments) to a particular process model (page). The size of nodes indicates the frequency of contributions.

As one can see only eleven (11) process models out of thirty-six (36) non-empty process models were collaboratively edited. The network reveals a rather high activity of user "VV" whereas user "OS" contributed only five (5) times to the process models that only in one process model (pages) all three users contributed whereas in all other cases only two users participated. This can be interpreted in two

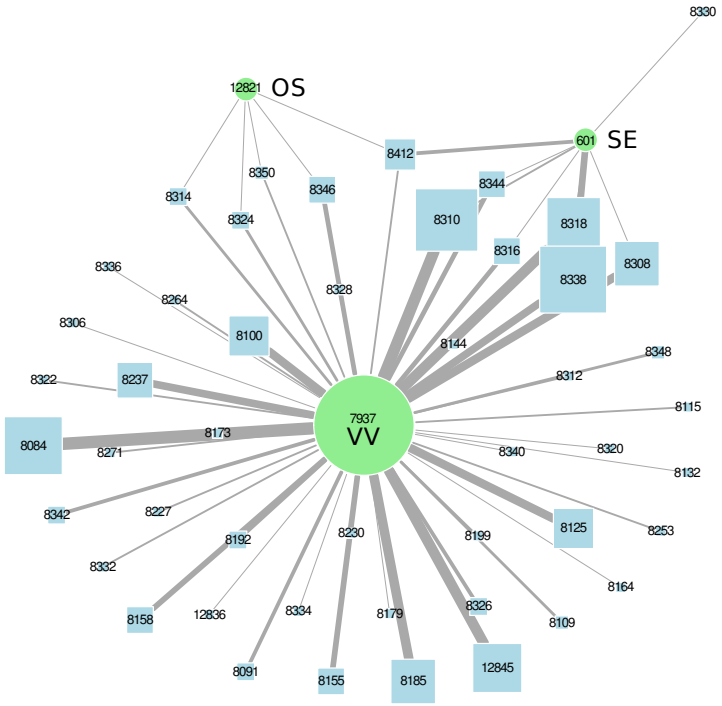

Figure 4. Visualization of user contributions to wiki instance as a two- mode network

ways: (1) users might have consciously divided work such that a maximum of two users co-author a process model, or (2) users have avoided involvement in a model that is already in "in discussion". A closer look at the pages which do not have contributions (revisions, comments) from multiple users shows that these process models are indeed very small in terms of model elements contained. This might be interpreted in a way that users do not feel obliged to contribute as the model is perceived complete or out of discussion. Through an additional analysis a correlation between the number of contributors (contributions) over the size of process models was identified. Yet, due to the limited size of the group and the limited number of models the correlation has not been found to be significant in a statistical sense. The largest process model "OS" with a size of 223 nodes and edges is the only one that involved all three contributors. The process model turned out to get too large to be easily understood and was later depreciated and divided into smaller and interlinked process models.

The transformation of the two-mode network view of collaborations into a one-mode view [26] yields that a rather strong relation between user "SE" and "VV" exists which may indicate that collaboration was more intense than between other users. The one-mode view underlines observations from the two-mode analysis where a weak tie between users "SE" and "OS" has been found.

V. Conclusion

The case-study described has been conducted as part of a larger research activity that aims at investigating the social processes involved in process redesign and how they can effectively supported by means of software tools. Although the case-study involved only a small group of actively participating individuals it reflects a typical scenario in organizational change projects where teams are generally kept small in size. However, as the case-study shows the community of stakeholders affected by a process redesign effort can be rather large which in turn indicates the potential and need for collaboration in the large.

The case-study has to be understood as an exploratory study that revealed first insights how a wiki has been integrated into a process redesign activity and which issues arose during it's use. In addition to interview data we examined a set of wiki instance data which revealed the frequency of creative interactions with the model artifact and the frequency of communicative interactions between participants. As this study is the first case-study of a series of planned case-studies of wiki-supported process modeling

we have gained valuable feedback for further enhancements of our wiki engine as well. This is especially of importance as several deficiencies in the diagram editor widget were discovered that led to initial breakdowns and affected fluent creation of process models.

A follow-up case-study is currently in progress and will engage a rather large group of 36 individuals over a time period of more than a year to investigate as well long-term wiki-supported collaboration in business process redesign. The wiki engine we adapted for the purpose of the case-study serves on the one hand as a platform for collaborative model development and on the other hand as an instrument to observe and analyze social interactions based on objective data.

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