Combining collaborative Modeling with collaborative Creativity for Process Design

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Abstract This paper presents a solution of how systematic design within facilitated walkthrough workshops is combined with phases of non-linear ideation for the purpose of collaborative process modeling. In the context of socio-technically supported co-located meetings, three design cycles were run which led to an evolutionary improvement. The result is a set of features as part of a socio-technical solution allowing to seamlessly intertwine creative phases with walkthrough-oriented inspection and improvement of models. The set of features includes the possibility of simultaneous brainstorming on several topics, variation of prompts per brainstorming topic etc. Additional features are described to support the facilitator.

Introduction

Our objective is supporting co-located collaborative design of business processes or work processes. Since the basis of processes usually has a linear structure according to the underlying sequences, they can be inspected or designed step-by-step. We have developed such a step-by-step method – the socio-technical walkthrough – and applied it in several cases to make sure that the points of view of various stakeholders can be systematically included. The method usually is conducted in computer supported co-located meetings where each aspect of the process is inspected and discussed step-by-step [11]. We have realized that focusing on such a systematical step-by-step procedure increases on the one hand the participation but neglects the available creativity of the participants [10]. Therefore we decided to seamlessly integrate features for creativity support into tools for process modeling as they are used in co-located meetings.

The relevant research is in the intersection of collaborative modeling [21] and support for collaborative creativity [18]. Collaborative modeling can serve as a methodological basis to include several stakeholders by combining methods of facilitation and computer support. However, the methods for fostering creativity (e.g. ThinkLets [2, 14]) are not seamlessly integrated into techniques for collaborative modeling. In the field of business process modeling, it is only acknowledged, that creativity is needed from time to time but is not systematically taken into account (cf. the spare referencing to creativity e.g. in [8]). There are no elaborated concepts available which describe how creative phases are supported in the course of the

analysis and improvement of modeled business processes. Consequently, the available modeling tools do not seamlessly integrate features for creativity support such as brainstorming. Even if brainstorming takes place it is conducted within separated tools and the result has to be manually integrated into the process modeling tool for further processing. This combination of different media is inefficient and can disturb the creative flow [4]. To our knowledge we have developed and evaluated the first tool for process modeling which seamlessly integrates brainstorming features. Fig. 1 illustrates how the results of applying the process modeling tool looked like in a concrete project (see the sub-sections on the first and second design cycle); it displays a transition which starts by collecting clustered ideas and leads to an increased structuring, e.g. by re-arranging the elements and aligning them with arcs.

Apparently, current concepts for collaborative modeling fall short in flexibly intertwining systematic modeling-walkthroughs with phases of non-linear ideation. Thus our aim is to overcome this deficit by a set of features that are integrated into process modeling tools and support collaborative creativity in the context of facilitated meetings. In order to do so we propose a methodology and prototype and evaluate technical features in several design cycles with the first design cycle establishing a baseline of properties of our solution including requirements to be fulfilled.

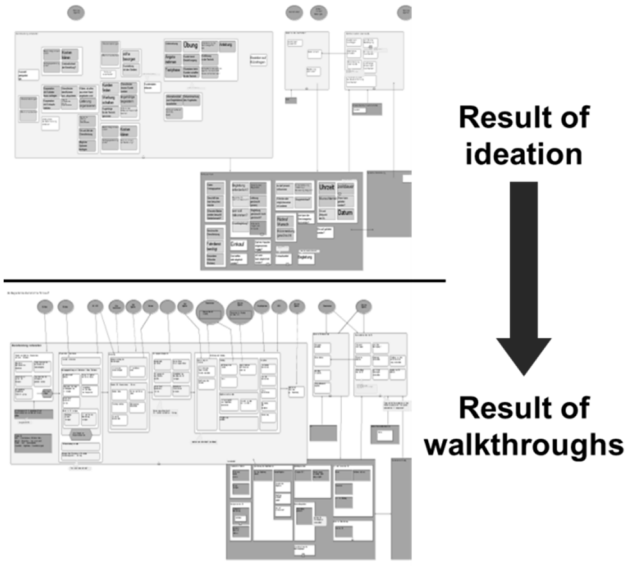

Fig. 1. Results of ideation with loosely clustered elements (top) and the final process model after a series of walkthroughs based on the previous ideas (bottom).

The next section provides a review of the relevant literature upon collaboration and creativity. In the following methodological section, the methodological background, which is based on an action research approach [13], is outlined. The devel-

opment and evaluation of the socio-technical solution is based on three design cycles, which lead to a set of features. The paper concludes with a summary of our findings and directions for future work.

Related Work

Process modeling is an established practice in most modern businesses, and it implicitly underlies many descriptions of how groupware can support collaborative work which usually integrates coordinative tasks as has been pointed out early by e.g. Malone and Crowston [17]. There is a variety of process modeling languages for the specific needs of e.g. software design [9]. Despite their obvious advantages, models often fail to cover real world phenomena as they force a once chosen level of detail to be carried out throughout the process (e.g. in [26]). This results in huge process descriptions that are hard to understand even for the modeling experts being involved in their creation. It has to be taken into account that many stakeholders in creative process design are domain experts with little knowledge about modeling methods. They need a modeling method which mainly supports communication between stakeholders and helps them to focus on the essential aspects. Therefore we mix formal with informal notational elements for modeling a process [11]. Other modeling notations such as the most recent incarnation of BPMN [19] also strive at becoming better understandable for non-expert modelers thus sacrificing rigor and the ability to directly compute code out of the resulting models. The developed features can at least partially be combined with this type of modeling notation.

While in some cases models are created by experts based upon upfront interviews or existing process descriptions, there are multiple concepts of integrating stakeholders into modeling. These range from stakeholders commenting on models in wikis [23] to a full scale integration into model manipulation [22]. The latter stream – called collaborative modeling [21] – stems from various different fields such as process management [22], system dynamics [24] and others [5]. The common goal is to to create a shared understanding about the problem domain among a group of people [1] thus resulting in a *"shared graphical representation of a system"* (derived from [21]). The underlying approaches are mostly based upon linear walkthroughs that are conducted during facilitated co-located workshops [11]. These walkthroughs are feasible e.g. when processes have to be visualized or analyzed based on current practice. By asking a number of predefined questions such as *"What comes next?"* or *"Who carries out that?"* the facilitator walks the participants through the process thus making sure that the participants don't miss out any important details [11].

While walkthroughs mainly are appropriate for reproducing, analyzing, refining and incrementally improving a piece of software, a dialogue structure of an interactive system [20]; a project documentation [27] or a process, their linearity hinders

the creative design of processes or their parts. The integration of electronically supported creativity techniques into collaborative process modeling has not been considered systematically so far.

Research on supporting creativity techniques with groupware tries to reduce the variety of possible methods to a number of comprehensible principles, such as building analogies, provocation, or random based impulses [14]). The ThinkLet approach [2] describes an advanced set of computer based methods of ideation including creative idea finding. It is based on elaborated psychologically and empirically substantiated work [25] and tries to overcome typical shortcomings of brainstorming in groups like e.g. production blocking or free riding [7]. However, creativity techniques and ThinkLets do not describe the interaction with artifacts such as process models. So far, the main problem is that current strategies of electronic brainstorming – as pursued with ThinkLets – are mainly focused on participants' producing textual notes and sentences, which are usually too long to be directly transformed into elements of a process model. Therefore we suggest referring to brainstorming techniques [12] which produce short notes on cards as a basis.

Furthermore, our approach can benefit from principles and heuristics which have been studied throughout several years [10, 16] in the context of collaboratively drafting design artifacts: Smooth transition must be possible and controllable by the participants between work in solitude and collaborative interaction, between private and shared space, and between divergent ideation and convergent synthesizing.

Methodological background

The empirical procedure took place as action research: We – the IMTM-research group at the University of Bochum – were involved as facilitators (three different persons) – in real projects or experimental settings where workshops were conducted to design or improve processes. Applying certain tools and methods to foster creative brainstorming can be considered as interventions. Afterwards, their effects have been exploratively investigated with the focus on identifying potentials of technical improvement [13]. The underlying objective was to fulfill criteria such as the quantity of ideas, the subjectively perceived intensity and continuity of ideation, the understandability of the contributions during discussion, and the smoothness of integrating them into process models. The exploration was based on recordings of the session, on observations and on semi-structured interviews in order to gather as much diverse information as possible thus fostering the future development of the set of features. The resulting material was selectively evaluated by searching for needs and possibilities of improvement which served as input for the ongoing design of the tool as well as the underlying methodology. The most promising candidates were selected and implemented as new interventions to be tested in a next cycle.

The empirical investigation took place in a special collaboratory at the University of Bochum (ModLab) where an interactive large screen can be coupled with mobile

devices through a wifi-network (c.f. Fig. 2). With the large screen, a whole process can be represented and the overall structure is comprehensible at a glance. Details can be studied by zooming or by standing directly in front of the screen. The model can be modified by directly interacting with the screen. Its development, including the brainstorming phases, was logged.

Fig. 2. The ModLab at the University of Bochum

The screenshot which can be seen in Fig. 2 on the large screen is based on a specific process modeling tool – the SeeMe-Editor[1] – which was designed to draft process diagrams and to present them step-by-step to support the communication about the represented models. The ModLab provides audio and video equipment to record the interaction during meetings in real time including the displayed material on the large screen and the entire room from three different camera angles. To understand the influences and characteristics of tools which support or hinder the participants' collaboration and the facilitator's work, we had an experienced observer simultaneously taking notes. After each workshop we also conducted semi-structured interviews with the participants and with the facilitator.

Table 1. Summary of design cycles.

	Task	Idea to assess
1	Identify suitable aspects of processes that are modeled afterwards	Brainstorming as a part of upfront planning for process design
2	Brainstorming as a part of process design with upfront planning of phases	Integration of brainstorming phases into process design

[1] See http://www.seeme-imtm.de for further details.

3	Brainstorming in process design with seamless switches between walk-through and ideation	Seamless switching between ideation and walkthrough oriented phases

In order to develop and improve the features for creativity support we went through three design cycles (c.f. Table 1). We started with an initial approach that contained no technological support for creativity itself but served as a predecessor for our tool design. Afterwards, we enhanced our modeling tool and evaluated the new version. With careful upfront planning we alternated phases of non-linear ideation with linear walkthrough oriented phases. The participants were scientist as well as people working in the area of services for elderly people. This study aimed at assessing the feasibility of the approach and testing the tool from the participants' as well as the facilitator's perspectives. The empirical investigation was a source for further requirements for the software as well as the setting. After integrating these findings into the tool, we continued with a third study. It was based on an artificial task as we wanted to assess to what extent seamless switching between linear and non-linear phases can affect the continuity of ideation. The participants were selected based upon their knowledge about the task which was the selection of applicants. Some of them had been in the situation of selecting applicants before while others were students that had taken part in selection processes.

Design Cycles

Baseline: Usage of conventional media

For preparing the design of processes or socio-technical solutions, we usually run brainstormings to collect first ideas about how the design should look like or which requirements have to be met. A typical example was identifying suitable services to support elderly people. The innovation was that these services should be ordered by using pen and paper technology. In order to identify appropriate aspects of the new services and their underlying processes, we used several of creativity techniques (c.f. [3] for a more elaborated description). Afterwards, the resulting ideas were assessed, merged and clustered during multiple phases. In between these phases the resulting material was digitalized for further refinement. While we found this alternating between different media to be useful for ideation as it sparked some more ideas [3], it also interrupted the workshop procedure multiple times. This observation supported the idea of integrating the results of brainstorming directly into the process modeling editor with which the ideas were transformed into the representation of a process-oriented socio-technical solution.

From these first brainstorming studies we derived a set of requirements which should remain fulfilled as a baseline when employing electronic means for creativity support:

- Working with cards /short notes which can be separately positioned, sorted, clustered and arranged is an indispensable means to flexibly integrate ideas of several participants into a process model.
- People are encouraged to create short notes which are sufficiently explicit to indicate what they have meant.
- The number of ideas (about 5 per participant in 5 minutes) is an average productivity threshold which is achieved with pen and paper based methods and should be maintained if electronic support is employed.
- Simplicity matters: People get quickly adapted to the tools they use and must not be distracted by the employed technology.
- People have a phase during which they work in solitude and decide by themselves whether they want to receive additional sources for inspiration.
- Phases of ideation and convergent consolidation (such as clustering along categories, aligning or prioritizing elements in a walkthrough) are flexibly mixed (see Fig. 3).

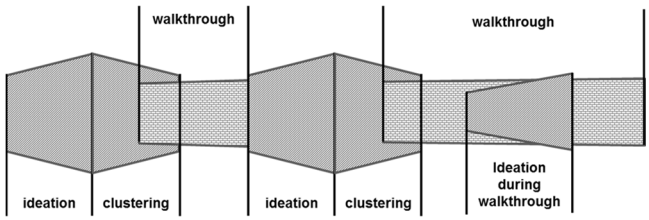

Fig. 3. Phases of linear walkthroughs combined with phases of ideation

First Improvement: Integrating brainstorming into a process modeling editor

We enhanced the process-modeling editor to allow for parallel contributions by multiple workshop participants. The enhancement consists of a simple web-interface (c.f. Fig. 4 bottom) that can be run by any browser capable device and be used by the workshop participants to contribute ideas. Typing in an idea into the text-input box of the interface results in a corresponding specially shaped (like a brainstorming card or post-it) element inside the model with the respective text as its label (c.f. Fig. 4 top). We deliberately chose to make the interface for the participants as simple as possible as we wanted them to stay focused on the task of ideation but not on a complicated interface.

Furthermore we enhanced the modeling tool so that the brainstorming cards can be dealt with in the same way like the other elements of the modeling notation. This allows facilitator to move items around, cluster them and create new items on demand. The facilitator can start a brainstorming session by creating an area - the braintable – that is represented with the process modeling tool and displays the brainstorming question, which is also shown on the participants' web interface, for example: *"Which activities are required to prepare a service?"*. Afterwards the facilitator asked the participants to contribute to this topic (c.f. Table 2). When the facilitator felt that a sufficient number of ideas was delivered, he started clustering the contributions by asking the participants which contributions should be put together. He also asked them to order the resulting clusters with respect to the process to be drafted.

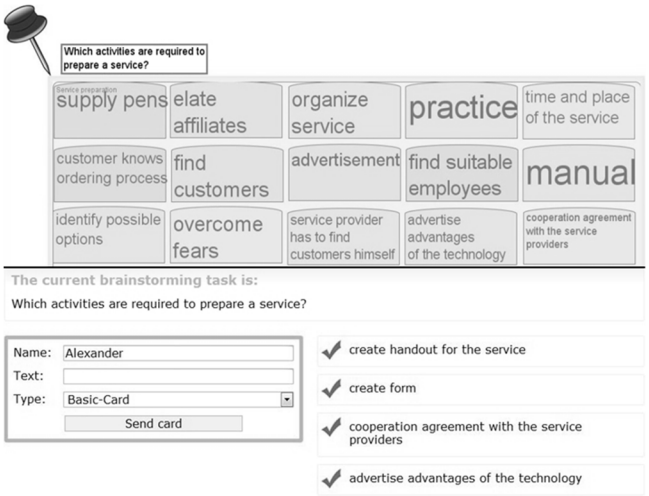

Fig. 4. A brainstorming area (top) and the corresponding web-interface for the participants (bottom).

This tool was applied in several workshops with the same participants and the same topic: Developing a process that allows elderly persons to order services by filling in forms with a digital pen. During the process, the data is then transferred electronically to a service agency which coordinates the services. Because of the complexity of the new service process, different stakeholders had to be included like people working in the area of services for elderly people, persons having experience with technically supporting elderly people, researchers in the area of improving housing for elderly people etc. They contributed their ideas about the activities and data which will be needed in such a new service delivery and coordination process. Afterwards, these ideas were sorted and aligned to a process structure. Conducting a series of workshops in this context gave us the opportunity to eliminate minor bugs and make slight improvements and to observe the resulting effects.

Table 2. Brainstorming Facts with 7 participants

	Brainstorming 1	**Brainstorming 2**	**Brainstorming 3**
Task	Activities that are needed to prepare a service	Data that is required from the user	Activities that are needed to coordinate a service
Number of elements	39	46	44
Time	6 Minutes	5 Minutes	8 Minutes
Duplicates	None	5	1

Throughout the workshops an observer was present who kept track of the interaction of the participants with the tool. An additional modeler helped with operating the modeling tool or entered text if necessary. We also took snapshots of the resulting model after each phase and used the respective timestamps to analyze the number of contributions during each brainstorming phase, resulting in the numbers presented in Table 2. After the workshop we interviewed the facilitator to evaluate the interface.

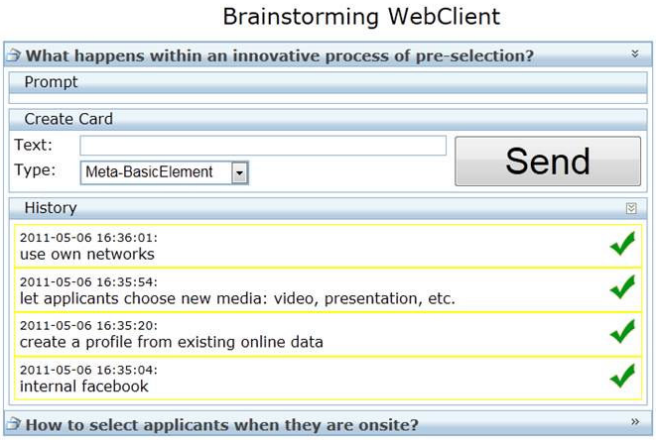

Fig. 5. The enhanced brainstorming interface for the participants with multiple brainstorming questions.

Analysis and measure for improvements: In the first workshop we found that the interface worked considerably well – at least with respect to the productivity of the participants as they contributed 129 items in 19 minutes (c.f. Table 2), indicating that they had no problems when using the interface. We also observed idle phases where people did not contribute but rather seemed to wait for further inspiration or for the next task. This lead us to the idea that participants should be able to freely switch between multiple brainstorming tasks that are available at the same time, instead of working on one topic after another as it was the case with the tasks shown

in table 2. Fig. 5 displays the solution which was employed in the third cycle. The snapshot shows that the participants works on the first question ("What happens within …") while the second question ("How to select …") is displayed at the bottom and can be activated whenever the participant wishes to switch to it. Furthermore, Fig. 5 shows that the participants can always see the history of their personal contributions which is another requirement which became apparent during our tests. The baseline requirements from the first studies were met. The participants were not distracted by the new method and were mostly willing to deliver short notes although the entry field allowed them for longer contributions. However, sometimes participants made rather long contributions so that the resulting text was difficult to read from a distance. Therefore we decided to crop longer texts at a certain point adding the whole text as a comment to the element. These comments can be hidden or disclosed if needed (Fig. 6).

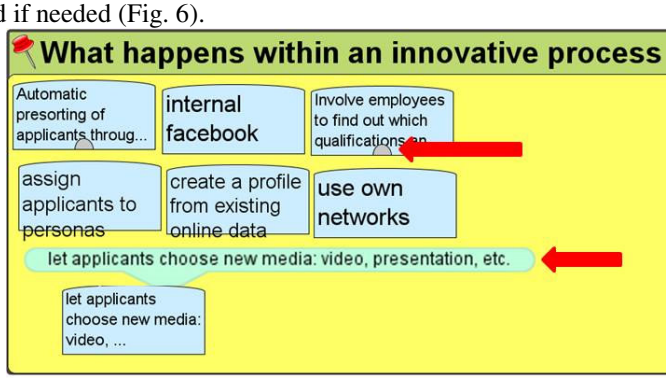

Fig. 6. Abbreviated contributions (marked with a semicircle) and a bubble displaying the complete contribution.

Most efficiency gains could be observed for the work of the facilitator. Time was saved since he had not to collect the cards and to pin them on a board (or to wait until the participants have done this). It was easy to cluster the items, to move them around, to create duplicates, to add comments, and to align the ideas to a process sequence. During the post-workshop interview, the facilitator reported that it was very difficult for him to deal with the brainstorming tables while keeping track of the communication in parallel. The resulting requirement is to allow the facilitator to prepare the brainstorming topics in advance and to activate or modify them during a workshop with a separated facilitator interface which is not visible for the participants. A further requirement was that the facilitator asked for an easy way to transform the symbol for the brainstorming cards into an element of the modeling notation like activities, events, roles or entities.

Second improvement: Fostering continuous ideation

After having adapted the tool with respect to the aforementioned requirements, we conducted a study with three workshops of 4 to 5 participants who were asked to go on with brainstorming ideas even after the facilitator has started to model a process on the basis of the received contributions. The underlying task was to design a process of selecting applicants for a place at university.

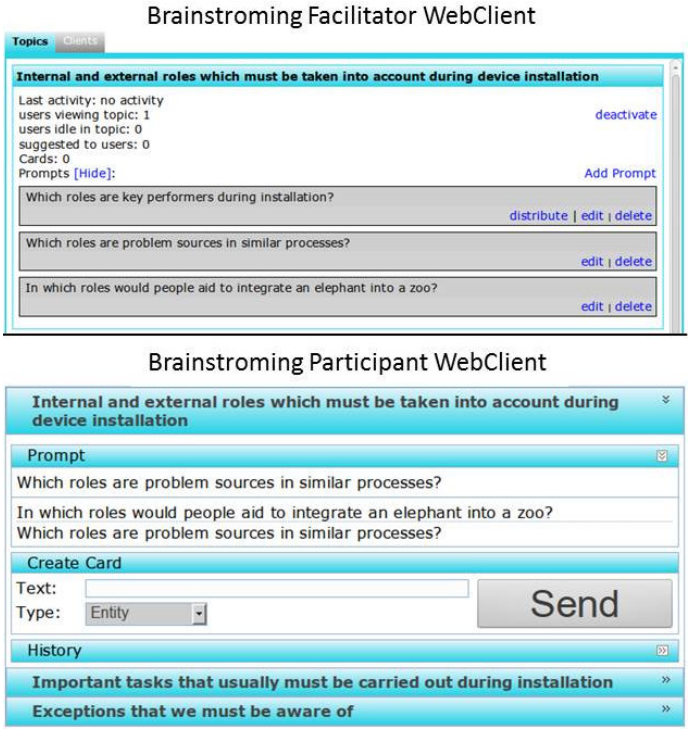

Fig. 7. The facilitator web-interface (top) and the interface of the participants (bottom)

Each workshop itself was divided into four phases with an initial explanation of the setting, where we introduced the topics to the participants. One of the topics covered the process of pre-selecting applicants and the other one the process of selecting applicants onsite. The participants of the workshop were also told that they were allowed to contribute to each of the two brainstorming areas at any time throughout the whole study. After this explanation, we asked the participants to start contributing using iPads. This phase lasted for about five to eight minutes. After this initial phase, the facilitator started clustering the contributed ideas with the help of the participants by asking the respective contributor to briefly explain her item and comment on its position in the process. The resulting clustering was done with

respect to both the content of the contributions and their sequence in an innovative process of selecting applicants. Additionally, the facilitator challenged the participants to contribute additional ideas. After finishing the clustering, the participants had the final opportunity to provide further contributions in a brainstorming phase of about 5 minutes. The facilitators could use a control panel which allows them to determine whether the contributing of brainstorming ideas can go on during the phase of clustering or not.

In the interviews after each study, the participants told us that they mostly sought for inspiration by looking at the contributions of others. This led us to the conclusion that each participant works at her own speed and that in order to fully exploit their creative potential each participant has to be supported and prompted individually. Therefore, we decided to add the possibility of multiple prompts for each brainstorming question that can be distributed individually [25]. We developed an interface that can be used by the facilitator to prepare a number of additional prompts for each brainstorming area (Fig. 7 top). This can be done before or during the workshop e.g. while the participants have already started contributing. In order to distribute the prompts properly, the facilitator interface provides awareness by anonymous statistics about for how long each participant has been idle (c.f. *users idle in topic* in Fig. 7). The assigned prompts appear on the participants interface next to the corresponding brainstorming question (e.g. *Which roles are problem sources in similar processes?* in Fig. 7 bottom).

Another possible improvement became obvious by analyzing the clustering phase: Oftentimes the text of the contributions was not self-explanatory. So it became necessary to explain it and to add this explanation as a comment. During the study, the facilitator had to create these comments herself while keeping track of the ongoing discussion in parallel. This leads to the requirement that the participants should be able to comment on their own contributions.

Summary and Discussion of the Features of the Tool Support

The process modeling tool

The ideation support within a process modeling tool proved of high relevance to allow for a smooth transition between phases of linear process design and more associative brainstorming (c.f. Fig. 3). For this integration, special areas for brainstorming (we call them braintables) can be created on demand anywhere within a process model. In addition, it is possible to transform every element within a process model into such a braintable in order to e.g. further dig into the details of this part of the process. All of these braintables have a suitable brainstorming question as a heading. It is possible to work on multiple parts (or perspectives) of the process at

the same time by offering multiple braintables in parallel between which participants can freely choose. This possibility was explained at the beginning of the brainstorming. The participants have intuitively used this option without being repeatedly encouraged by the facilitator to do so.

While the participants can only see a list of their own contributions on their respective web interface, all contributions of the whole group have to be visible within the respective braintable in the context of the emerging process model. While the contributions are displayed in a format which is similar to paper cards by default (c.f. Fig. 6), the participants may also select that their contribution appears as a symbol of the process modeling notation. This option was not widely used; however the facilitators required that the neutral cards can be easily converted into process modeling symbols. These cards or symbols can be easily dragged and dropped and be embedded into other elements of the process model. We focus on a type of brainstorming where cards of fixed sizes are used since also the elements of most process modeling notations use symbols of limited size. Because of this limitation the length of the text entries is also limited so that the cards remain readable from a distance. However, if a participant's contribution exceeds the limit of length, the whole text has to be captured as well. This is done through a comment which is attached to the respective contribution and can be flexibly hidden or shown (c.f. Fig. 6). Furthermore, this kind of comments can also be added afterwards by the originator of a contribution to add further explanation.

Participants web interface

While the interactive wall and the canvas of the process modeling tool are the space of direct collaboration, the participants' web interface is their tool for work in solitude (see Fig. 7 bottom). Mostly they stayed focused on this tool after having checked if their first contribution is conveyed to the public screen. Afterwards a phase followed without glancing on the interactive wall. The interface allows them to enter text to make several contributions to a topic. Furthermore, it is possible for the participants to freely choose between multiple brainstorming topics if the facilitator has opted to provide them (e.g. *"Important tasks that usually must be carried out during installation"* and *"Exceptions that we must be aware of"* in Fig. 7 bottom. They may also select a symbol of the process modeling notation to determine how their contribution refers to the process model (c.f. *type* in Fig. 7 bottom).

In the context of a brainstorming question the participants can see various prompts which may foster their inspiration during the brainstorming. The need for prompts is described in the literature [25] and became obvious in the third design cycle when we tried to encourage the participants to continue with brainstorming. So far, we have not tested in a fourth cycle whether these prompts have a positive effect and do not violate the baseline requirements such as simplicity.

In order to keep track of their own ideas the participants can see a history of their own contributions for each brainstorming topic. After having sent a contribution,

the respective participant may also add a comment to it. This is especially important during post-processing of the items as it is very likely that some contributions require further commenting due to their being very short. The participant's web interface is oriented on the role model of conventional brainstorming with cards: as soon as the idea is delivered to the public (i.e. conveyed to the modeling editor) it cannot be changed anymore – comments can only be added to the own contribution. This restriction was challenged by the participants who expected that the computer-based handling of cards should allow them to edit or delete their ideas afterwards. Meeting this expectation would allow the participants more flexibility but can also harm the consistency of the public presentation.

Facilitator web interface

The facilitator is responsible for integrating the brainstorming phases into the walkthrough oriented drafting of the process model. It proved insufficient to support this task exclusively with the integrated features of the enhanced process modeling tool. Therefore, additional support is provided with a separate web-interface that allows the facilitator to prepare brainstorming topics/questions and a number of prompts in advance. Furthermore it has to be possible to add or edit prompts and brainstorming topics on demand during the sessions.

Additional statistics – for example about idle times – allow the facilitator to understand the progression of the brainstorming. These statistics are anonymized: For instance, the facilitators can only see that one or more persons are inactive but not who they are. Based upon these statistics, the facilitator may influence the brainstorming procedure by deciding which brainstorming topics can be worked on, e.g. whether the participants should focus on one topic or whether they can freely choose between various brainstorming questions. Furthermore the facilitator may also flexibly assign prompts to all participants or to a selected group (e.g. those who stayed inactive for more than five minutes or those who limited their contributions to a single area while multiple areas are available). Finally the facilitator may also start and stop the brainstorming mode on demand if clustering or walkthrough oriented structuring has begun. This facilitator support has been derived from the third design circle but so far not been tested with respect to the complexity and effectiveness it causes during process modeling workshops.

Outlook

The presented solution helps to combine phases of non-linear ideation with systematic participatory design within facilitated, walkthrough-oriented workshops of process modeling. The collaboration support is focused on co-located meetings where various stakeholders are systematically included to discuss a new business or work

process. One issue of innovation is that the support of collaborative creativity techniques is not separated from the actual design tool but is integrated into it. This is of general relevance for CSCW since the features which we have developed can also be a role model for other areas such as collaborative architectural design, plant layout, requirements engineering etc. Furthermore, the developed tool provides much more flexibility to the brainstorming participants than traditional approaches. They do not have to wait until everybody's contributions are collected before they proceed with the next topic; they don't have to deal with a topic which they are not interested in but can switch to other issues and they can decide flexibly whether they want to read what others have contributed or stay with their own ideas. This flexibility is so far hardly taken into account by studies which explore the effects of electronic brainstorming (cf. [6, 15]). However, the possibilities for flexibility lead to the question whether some of the remaining restrictions, such as being not able to delete or edit contributions which have already been displayed to the public or to comment the ideas of others, should be overcome. This consideration refers to a trade-off between flexibility and consistency which requires further evaluation.

The features of the tool can be enhanced e.g. with respect to collaborative clustering, sorting and filtering. It can be evaluated to what extent further features for supporting convergence (sorting, prioritizing, comparing) can be integrated. The ongoing evaluation may focus on whether the tool support for facilitators can be easily handled during facilitating a meeting, or whether the support leads to distractive effects which restrict the facilitator's attention towards the ongoing communication. Furthermore, supporting the participants' imagination with prompts could be enhanced: Instead of only using textual hints, multimedia support is helpful to inspire them (e.g. with pictures, statistical data, music, stories etc.).

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