Awareness support for combining individual and collaborative process design in co-located meetings

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Abstract. The collaborative design of complex systems is a challenging task. It requires phases of linear as well as creativity oriented work. Also phases of collaborative work have to alternate with work in solitude, requiring a smooth transition between them. This in turn results in awareness becoming a crucial factor. Within the context of designing socio-technical processes through modeling we have developed tools and methods to integrate individual and collaborative creativity into modeling with special respect to awareness thus allowing for a smooth transition between phases of working in solitude and phases of collaboration. We have conducted multiple experiments on the subject following an action research approach which allowed for reflecting on the influence of awareness on collaborative process design in co-located meetings while also improving the socio-technical setting they were applied in. Derived from our findings we show requirements for further development of the socio-technical setting and show future directions such as the integration of the described setting into other areas of design.

Keywords: Awareness, Brainstorming, Collaborative Modeling, Creativity Support, Interactive Large Screen

1. Introduction

The collaborative design of complex systems is a challenging task also considered as a wicked or ill-defined problem (Rittel and Weber 1973). We have studied phases of design in which several people – including stakeholders and experts – conceive diagrams of processes which include activities, roles and resources within socio-technical systems. We have studied co-located meetings and prototypes to support process design, and have identified needs to support mutual awareness. In this paper we analyze these needs and propose solutions of how to meet them. This work is based on two central assumptions:

1) We suppose that designing socio-technical processes is not only a linear task but needs the integration of creativity oriented collaboration (Fischer and Herrmann 2011).
2) Furthermore we suggest that intensive discussion and work in solitude alternate (Herrmann 2010). This finding is also backed by psychological research (Diehl and Stroebe 1987) which detected that creativity is blocked if individuals have always to be attentive to an ongoing interaction with others. Therefore, a smooth transition between work in solitude and collaboration has to be supported.

One crucial aspect of switching between work in solitude and collaboration is awareness: While an individual focuses on preparing and describing own contributions s/he can or needs to be aware of what others are contributing or discussing. In accordance with Dourish and Belotti (1992, p. 107), we consider awareness as “an understanding of the activities of others, which provides a context for your own activity. This context is used to ensure that individual contributions are relevant to the group’s activity as a

whole, and to evaluate individual actions with respect to group goals and progress". In the context of collaborative and creative process design, awareness includes that

- a participant can become inspired by what others have contributed,
- s/he realizes when others refer to her/his own contribution,
- s/he will understand that the own ideas have to be explained more explicitly to others etc.

We have collected experience with several cases where complex models have been collaboratively drafted (Herrmann 2009). This experience can be related to the context of *collaborative modeling* (Renger et al. 2008), also called *group model building* (Rouwette et al. 2000) which has been widely discussed in literature. Renger et al. (2008) provide a framework to analyze collaborative modeling. With respect to their framework, the collaboration can be described by referring to the following dimensions:

- The number of modelers or stakeholders working together to achieve a first draft, to improve it, to finish the layout, to help with the quality improvement, etc.
- The cooperation between modelers and domain experts, facilitators etc. (for a more detailed differentiation of roles see Renger et al. 2008).
- The course of modeling, e.g. sequenced modeling or modeling in parallel.
- Delegation of modeling to modeling experts (who contribute as chauffeurs) vs. modeling contributions by everybody.
- Modeling of existing processes vs. modeling of new processes which usually don't have a pendant in reality.

We suggest that the combination of linear analysis and development of models with creatively drafting them represents another important dimension, and that the relevance of creativity immediately leads to the necessity of smoothly switching between individual and collaborative design on the basis of awareness support. Therefore the aim of this paper is

1) to describe the technical features and the characteristics of socio-technical solutions – especially awareness support – which foster creativity and the integration of individual and collaborative process design.
2) to make the design rationale behind the developed features comprehensible by describing the need for awareness as well as its effects.

Therefore we explain how we have supported process design in a series of varying socio-technical settings. Each setting was characterized by a certain procedure of running and facilitating workshops and of employing and testing new methods and technical means. After each workshop we reflected on the advantages and disadvantages and tried to improve the socio-technical setting. During these cycles of incremental improvement we have increasingly realized the relevance of awareness support. Consequently, the paper is aligned to a cyclic design approach:

1) Derivation of requirements for a socio-technical solution based on previous experience.
2) Developing a solution for the integration of creative design into process modeling.
3) Conducting a case study and deriving new requirements.
4) Improving the socio-technical solution.
5) Running a new study and refining of the requirements.

From a methodological point of view our empirical work employs an explorative approach rather than hypotheses testing. The effects of our prototypes and the variations of facilitation strategies were mainly observed with the goal to detect potentials for improvement. The main criteria were the broadness of the ideation outcome – as it was perceived by the facilitator and the participants – and the efficiency of documenting ideas and processing them in the course of the design. To test the prototypes in a socio-technical setting, we have organized and facilitated the workshops by ourselves and reflected on them afterwards on the basis of notes we took as observers, by interviewing participants and by inspecting video-recordings. Therefore, our approach follows the concept of action research (Hult and Lennung 1980).

We typically worked with groups of 4 to 12 people who collaborated to draft diagrams which describe new organizational or socio-technical processes. These groups are supported by a facilitator and in some cases by a modeler. A typical project where we run such workshops aimed on the development of services supporting elderly people to manage an autonomous life at home for as long as possible. The services had to be newly designed since it was intended to employ a new technology for submitting the data needed to order services and to coordinate them efficiently. The development of the socio-technical processes for this project is the background of the case study described in section 5.

In what follows, we briefly describe existing work and show how our work fits into this context (section 2). After that, we elaborate on our previous research and development activities in combining creativity and process modeling (section 3) and our current technical approach to implement this combination (section 4). In the following section (5) we describe an initial case study conducted in the context of the project described

above. Based on this study and the observations and requirements stemming from it, we conducted a second study focusing on the interplay between awareness and ideation. Section 6 gives an overview over this study and our findings. The paper concludes with recommendations for further development of the socio-technical setting and directions for future research (section 7).

2. Research Approach and Challenges

It is a specific and challenging characteristic of co-located collaborative modeling efforts that they require creativity of the participants. With respect to the support of creativity we expect the numbers of creative ideas to probably increase if they are developed by a group of different stakeholders who have differing backgrounds and expertise. This complies with Csikszentmihalyi's (1996) observation that "an idea or product that deserves the label 'creative' arises from the synergy of many sources and not only from the mind of a single person". We call this phenomenon "collaborative creativity" (Mamykina et al. 2002). Collaboration can be considered as a process where people work together and usually know each other, and at least have opportunities to give feedback to each other's ideas and work. Fischer et al. outline that collaborative creativity (in their words "social creativity") draws advantage from including different people with different backgrounds (spatial, temporal, cultural etc.) and that conceptual collision can enrich the collaboration (Fischer et al. 2004).

Within a group of different people who do not know each other very well, a number of creativity barriers have to be taken into account which are described in the ideation literature and which also apply to our setting. Working in groups may prove less effective for various reasons (Diehl and Stroebe 1987; Santanen 2005): Production blocking

may occur because people wait for their turn to speak, especially if a process is linearly drafted. While waiting they may forget some ideas before they can report them and they may not generate new ideas while listening to others or trying not to forget their own thoughts. Free-riding occurs when people stop generating own ideas, but rely on others. A further problem is the fear of being evaluated by others (evaluation apprehension). A general obstacle is that people stay within the boundaries of a certain kind of ideas which was voiced at the beginning of a brainstorming session (cognitive inertia, cf. Briggs and Reinig 2007). This problem of cognitive inertia can be reduced by strategies of offering various and varying prompts (Santanen et al. 2004) to the participants in the course of ideation. In the case of the combination of process modeling and creative drafting, it is a special requirement that a socio-technical solution integrates this prompting into the participants' collaboration. With respect to awareness, such a solution is faced with ambivalent requirements: On the one hand, awareness may disturb the creative flow and therefore cause production blocking; it may also support freeriding or evaluation apprehension. On the other hand, being aware of what others are doing may serve as additional prompts which inspire creative work. Taking into account this contrast, the central question of this paper is: How is awareness in technically supported creative meetings influencing co-located collaborative design focused on shared artifacts such as diagrams of process models?

Within our case studies we have used a special facilitation collaboratory (ModLab) where input devices (Laptops, iPads) and a large interactive screen can be coupled to support the drafting of process models (see section 4 for details). Based on preceding experiences with other workshops (cf. section 3), we found that we had to employ methods and tools which help to meet the following challenges:

- Sequenced process modeling and brainstorming have to be combined. During the ideation, the participants should be continuously aware of the overall task of drafting a process diagram.
- People cannot have the complete process in mind but need to jump between different areas or phases of the process when they firstly start to draft it.
- There are manifold reasonable options for collaboration, including thinking in solitude about possible contributions to teamwork, taking inspirations into account by being aware of what others are contributing, varying the intensity of communication or alternating parallel drafting of process parts with phases of deliberately drafting a process step-by-step.
- The stakeholders should have the possibility either to directly contribute parts of the process diagram or to delegate this task to an expert modeler.
- When we tried to choose appropriate tools and methods we became aware of the following limitations:
- Brainstorming tools and process modeling tools are mostly separated.
- Most electronic brainstorming systems (EBS, cf. Nunamaker et al. 1991) are text based – while process modeling is focused on the collection of graphical elements of different types.
- Linear walkthroughs, which are often recommended, (cf. Yourdon 1979) are an appropriate means for careful inspection but are suboptimal for creative processes since they urge people to be passive and to wait for longer time periods and therefore lead to production blocking.

- The recommended procedures for technically supported facilitation of ideation (Briggs and de Vreede 2009) do not sufficiently take into account how people's awareness of other activities influences their creativity.

To overcome these limitations, we have created a tool integrating electronic brainstorming and process modeling. Before we describe two studies of its usage, in the following sections we describe requirements stemming from predecessors of our tool and the context we are using it in.

3. Integrating creativity into process design workshops

3.1 Predecessors

3.1.1 The Socio-Technical Walk-Through (STWT, Predecessor 1):

A frequent design task is to appropriately integrate an IT-infrastructure into an existing socio-technical process. To understand this process and to plan its modification, we usually conduct walkthroughs in a series of workshops as described by the STWT method (Herrmann 2009). We start by interviewing relevant process participants and process owners before running the first workshop. These interviews are used to create a high level model of the process. Afterwards we bring relevant stakeholders such as process participants, domain experts and IT-specialists together.

The workshop starts by presenting the high level model of the process. The facilitator explains it and walks through the process by asking the participants what they do at a certain point, what they need in order to perform the task at hand or who has to carry

out the task. In the course of this communication, the facilitator transfers the contributions of the participants into elements according to the modeling notation. He is supported by a modeler (also called chauffeur, cf. Regner et al. 2008) who operates the modeling tool. All contributions are gathered sequentially step-by-step by repeated walkthroughs.

If an entirely new process or even new parts of it have to be created, this sequentiality being enforced by the walkthrough limits the necessary creativity. Process walkthroughs are reasonable if questions such as “What next?” or “What is needed here?” are applicable. In other situations where empty space of process models have to be filled creative ideation is needed which produces a lot of ideas. However, if many contributions at the same time came to the participants’ minds, people probably have to wait too long for their turn to speak in the course of a facilitated walkthrough, and therefore forget some ideas before they are able to report them, or they may not generate new ideas while listening to others. Since the walkthrough requires continuous attention for the ongoing discourse, the participants hardly can switch to work in solitude for producing creative ideas. However, it became apparent that the participants in the STWT pursued their own thoughts from time to time and afterwards had to find their way back into the discussion. In these situations it was helpful that the STWT discourse continuously leaves traits in the process models which were visualized on a large screen (see section 4.1). This visualization supports a kind of incidental awareness which helps the participants to synchronize themselves with the ongoing discussion.

3.1.2 Card-Based Brainstorming (Predecessor 2):

If it is necessary to gather ideas for the tasks, roles, resources etc. of a new process, brainstorming with physical cards is a possible approach. Every participant receives a stack of cards, the facilitator presents a brainstorming question that addresses an important aspect of the process as a prompt and asks the participants to write their ideas onto the cards. After a while the cards are gathered and pinned to a board to be explained and clustered in relation to their content or to their position in the process. This provides awareness of others' contribution at a relatively late point of time, and people cannot react to other contribution or get inspired by them. Therefore, we sometimes ask the participants whether they want to complete the collected issues after they have been collected. However, for process brainstorming this can be difficult for them because they have already left the brainstorming mode and are not really aware of the whole process model where they could detect lacking aspects. After the clustering, the facilitator usually takes a picture of the cards, transfers them into graphical representations and inserts them into a process model. This model is displayed in the following workshop in order to continue its development.

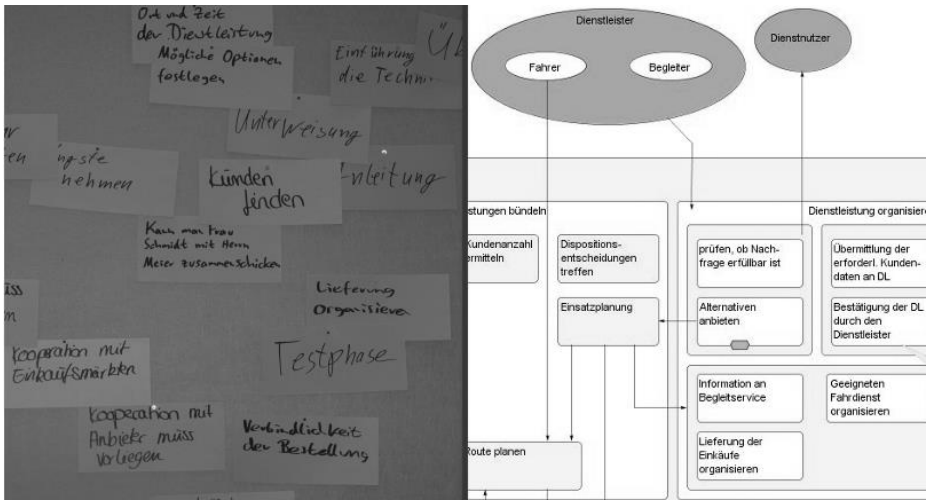

Figure 1. Clustered brainstorming cards (left) compared to a process model (right)

The card based brainstorming has the advantage that a participant can work with the cards, modify them, exchange them, and personally order them before s/he passes the cards to the facilitator. During this phase, several participants can work in solitude and parallel. However, they have no incidental awareness of what others are producing and the decision that the individual ideation switches to collaborative discussion is made by the facilitator. Further disadvantages are that someone has to transcribe the cards before they can be integrated into a digital process model – this causes a break and prevents a smooth interplay between brainstorming and the refinement of the process model. Furthermore, the visualization of the model that evolves from the transcription of the cards has an entirely different look and feel than the original cards (see Figure 1). This forces the participants to completely re-orientate. Furthermore they do not have awareness support to recognize whether their original ideas find their way into the final outcome of a process model.

3.1.3 Electronic Brainstorming (Predecessor 3):

As card based brainstorming does not support the seamless integration of the results into the process model well but appears to be useful for ideation, we tried an electronic brainstorming tool enabling participants to contribute to the brainstorming with a laptop or similar device. Mindmeister[i] – the tool we used – is web based and provides different user interfaces for the participants and the facilitator. The facilitator presents a brainstorming question that appears on a large screen in front of the participants. They enter their contributions on their laptop and send them to the screen with a simple user interface that consists of only one text input field. The facilitator stops the brainstorming after a couple of minutes and clusters the contributions according to different aspects of the process. After the workshop, contributions are converted into elements of a graphical process model, which is then used in the following workshop for further development.

In contrast to card-based brainstorming (Predecessor 2), this approach does not lead to the necessity to transcribe the contributions. Furthermore it is possible to work in parallel and to contribute anonymously. Moreover, people can be aware of what others have contributed and can therefore be inspired to add further ideas. However, someone still has to transfer the brainstorming items into a process model, and the brainstorming is interrupted during the process-related clustering and sequencing of the items. Since the traditional brainstorming with cards is more or less projected on the electronic medium, switching between work in solitude and collaboration is still a matter of control by the facilitator. However, with the possibilities of electronic brainstorming the desire

emerged that further ideas could be added even if the facilitator has already started to insert the contributions into a process model.

3.2 Derived Requirements from the Predecessors

Our experience with these predecessors combined with the challenges that were outlined in section 2 led to the following requirements for the integration of electronic brainstorming with co-located collaborative modeling:

- The ability to contribute in parallel to the process diagram helps to prevent production blocking and thus is an integral part of an environment to promote the creative development of a new process.
- The complexity threshold for the participants to contribute to the brainstorming has to be as low as possible to enable them to focus on their creative task, and to leave cognitive resources for being aware of others' contributions.
- Awareness support should help the participants to decide whether they want to go on to think in solitude about their contributions or whether they take the contributions of others as an inspiration or start to interact with them.
- Brainstorming contributions have to be directly integrated into the process model in order to make the orientation for the participants easier and to make them aware of the overall task to which they contribute.
- The brainstorming results should appear as elements of the process model while the look and feel of real brainstorming cards as well as their character of tentativeness is still maintained.

These requirements have served as heuristics for the development of features that support the integration of brainstorming into a co-located collaborative modeling environment. Additionally, the tools were integrated into an existing socio-technical infrastructure that will be described in the following section.

4. Technical Infrastructure and Environment

4.1 Environment: A Collaboratory for Process Modeling

Figure 2. The ModLab – University of Bochum

The tools we developed are applied in a facilitation collaboratory (ModLab) at the University of Bochum, Germany (Figure 2). Its centerpiece is a large, high-resolution interactive screen (4.80m x 1.20m; 4320x1050 pixels). The whole surface is touch-

sensitive and allows seamless operations over the whole width of the screen. Additionally, a wifi-network enables communication between the audience and the large screen with suitable devices like laptops or smart phones.

4.2 The SeeMe Modeling Method

We employ the SeeMe modeling method (Herrmann and Loser 1999) for the development and visualization of socio-technical processes. SeeMe is comparable and compatible with many other modeling methods but has some distinctive features enabling semi-formal modeling: explicit indicators for incompleteness and uncertainty, rough as well as complete specification of relationships, multi-perspective decomposition of elements, indication of space for free decision-making. The advantage of such a semi-formal representation is that it can both express the contingent relationships of social structures and the formal specifications of a technical solution.

The related SeeMe editor[ii] serves as a graphical modeling tool for the development of SeeMe models. It was initially developed to be chauffeured by a modeler in a collaborative environment with different stakeholders, users and domain experts while a facilitator manages the communication. As it is developed by ourselves, we are able to enhance it to meet the requirements that we derived from the predecessors as well as to fit it into the ModLab infrastructure. We will explain these enhancements in the following subsection.

4.3 Integration of Electronic Brainstorming into Collaborative Modeling

After having reviewed the predecessors (cf. section 3), we developed a first prototype covering the requirements presented in section 3.2. The solution includes two different user interfaces, one for the facilitator and one for participants. The interface for the facilitator is an enhancement of the SeeMe modeling editor with a special UI for the purpose of facilitating a brainstorming session (see Figure 3). It is designed to be operated entirely on an interactive large screen and enables the facilitator to determine one or multiple areas inside the model where the brainstorming cards will be collected (see the frame at the bottom of the needle in Figure 3). We will describe the facilitation method and the handling of the interface in section 5.

Figure 3. The SeeMe Editor – enhanced for the purpose of brainstorming

The interface for the participants has an entirely different look and feel (see Figure 4). It is a small website that can be operated on any device supporting a web-browser so that all participants can contribute to the brainstorming with their own devices like a laptop or smartphone. The UI itself is designed to be as simply to use as possible. To

contribute to the brainstorming participants just have to enter their contribution into the *Text* field and press the *Send card* button. Optionally they can enter a name or a pseudonym to personalize the contribution or indicate an element type of the SeeMe modeling language if they consider this to be necessary. The brainstorming topic on top of the interface as well as a chronological listing of their own contributions on the right serves as a feedback mechanism for the participants.

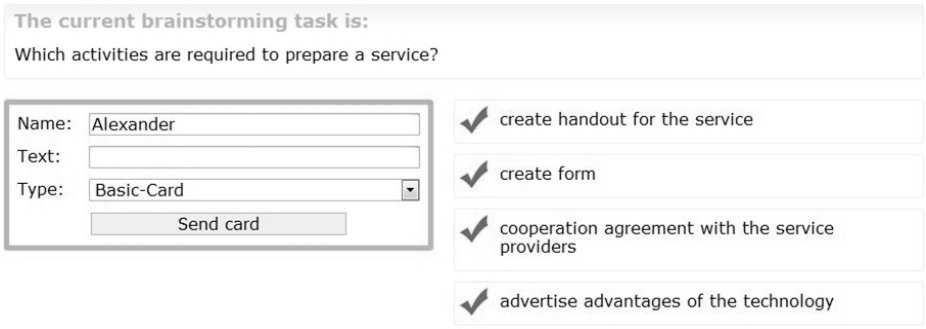

Figure 4. The brainstorming web interface

The awareness for contributions is intentionally distributed between the web-interface and the large screen: While working with the participant interface, the participants decide to stay with their own contributions and not to be distracted by others' ideas. If they want to be inspired by the ideas of others they can decide to switch their attention to the large screen. This constellation allows different modes of collaboration.

5. Study 1 - A Socio-Technical Procedure for the Integration of Brainstorming and Process Modeling

Our first case study focuses on a series of workshops planned to develop a process for a newly-created service offering company for elderly people during their weekly

shopping. The goal of the workshops was to develop a process for the coordination of several service providers and the communication between them and the customers.

The whole workshop was planned to last 3.5 hours. We invited 11 individuals to serve as participants. Their heterogeneity covered aspects such as gender (5 female, 6 male), age (range: 26 to 57 years), status (students, postdocs, research assistants, full professors, practitioners) and professional background. The participants contributed their experience from several perspectives based on their professional background. Some of them were involved as academics in the research on process design. Others serve as domain experts and service professionals who work in nursing homes or as service providers and understand the needs of elderly people.

When preparing the workshop, we created a high level model of the process that was displayed on the large screen to serve as the focus of the workshop. It included three main activities (*service preparation*, *coordination of service requests* and *service provision*) that covered the coordination and communication aspect of the process. Furthermore we added one entity (*required user data*) to prepare the planning of the IT-infrastructure.

As it was unsure whether the participants would be able to handle the technology from the start, we began the workshop with a warm-up. The facilitator opened an empty modeling area and created a brainstorming field (see Figure 3) with enough space for the expected contributions. Then he brought up the following brainstorming question: “Where do you want to go on vacation next summer?”. Additionally he provided an URL that the participants were supposed to enter into the browser of the laptop in front of them. This URL led them to the brainstorming web interface (see Figure 4) and they were told to start contributing to the question.

After the facilitator felt that all participants would be able to handle the web interface he told them to stop and opened the model that was created during the preparation of the workshop. He created a brainstorming area around the activity *service preparation* and provided the associated brainstorming question: “Which activities are required to prepare a service?” (See *Brainstorming 1* in Table 1) Afterwards the participants were told to press the reload button on their browser, choose the type *activity* and start with the brainstorming.

Table 1. Brainstorming Facts

	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
Area of the model	Service preparation	Required user data	Coordination of service requests
Number of elements	39	46	44
Time	6 Minutes	5 Minutes	8 Minutes
Duplicates	None	5	1

The first brainstorming lasted about six minutes before the facilitator told the participants to stop as he felt that there were no more ideas to be expected. Afterwards the facilitator gave the opportunity to explain unclear contributions and clustered the collected items according to topics that emerged during the discussion. If duplicates appeared (in the second and third brainstorming) they were merged and marked with a comment. The facilitator managed the discussion and the clustering by dragging the contributions on the interactive large screen. Afterwards, the clusters and their chronological order within their parent-activity *service preparation* were discussed. The facilitation of this discussion led to moving the clusters of elements to their appropriate destination within the process model.

The following two brainstorming tasks (see *Brainstorming 2* and *Brainstorming 3* in Table 1) were similarly facilitated. Only the brainstorming prompt and the area of the model, to which the collected items were assigned to, had to be newly specified.

5.1 Insights into the integration of brainstorming into process modeling

To evaluate the case study, one of the authors served as an observer thus participating in the workshop. He also helped designing the study as well as the tools that were used and has more than ten year of experience in research. His goal was to document firsthand experience with the tools based upon the following categories:

1) Interaction of the participants with the tools
2) Interplay between the tools and the socio-technical environment
3) Effects of the environment on the participants ability to focus on brainstorming related tasks

His previous involvement in designing the tools enabled him to distinguish between influencing factors of the software and effects that were caused by the procedure of the workshop. In order to avoid any biases considering his involvement in the design of the tool, we also videotaped the workshop from three different angles and analyzed the resulting material based upon the categories described above. This analysis was conducted jointly by all three authors. We are quite aware that – considering the observer also being part of the analyzing team – we cannot fully avoid the aforementioned bias. However as our focus was not on hypothesis testing but rather on gaining insights into the aforementioned categories, we accept these biases as we do not perceive them to impact our findings in a major way.

In addition to this, we also conducted a qualitative interview with the facilitator, aiming at gaining insights into his experience during the workshop. Within this interview he gave a report of his experience with the tools and with the procedure of the workshop. He also compared his experience with the facilitation of previous STWT workshops and described advantages and disadvantages of the employed procedure. After each brainstorming phase we created snapshots of the resulting model. The timestamps of these models as well as the observation protocols allowed us to identify the number of items that were contributed in a certain amount of time. Table 1 shows the corresponding results.

The following selected results of our case study provide an insight into the most obvious strengths and weaknesses of the technical infrastructure which have to be taken into account for preparing the second case study on the interplay between creativity and awareness.

1. The participant's interface was easy enough to use

Using an electronic input device was not distracting compared with the cards- and pen-based brainstorming. According to the numbers (see Table 1), it worked quite well, as 11 participants contributed 129 brainstorming items in just 19 minutes. On average, every participant contributed an idea at least every 90 seconds. We conclude that the cognitive load being caused by using the input device does not prevent people from being aware what others are doing.

2. Clustering the contributions after the brainstorming

The interactive large screen enabled the facilitator to move elements to their designated destination with a simple drag of his fingertip. He handled this task while still being able to keep track the communication. Merging of duplicates, however, was not

supported by a suitable function but was managed by deleting one element and adding a comment to the remaining element that it occurred twice or more times.

Easily overviewing and moving around the brainstorming items was supported by the fact that they were small enough, since the participant's interface limits contributions to a length of about 40 characters (see Figure 4). Problems occur if elements have to be dragged over longer distances e.g. more than 3 meters. Furthermore the facilitator was not sufficiently supported to move a whole set of selected elements and to allocate them to a specific destination or element of the model. It was quite awkward that all contributions had to be moved one after another. We consider this as a source of distraction which prevents participants from focusing on the actual task.

3. The participants could not change or enhance their own contributions

Since the contribution length was limited, some of them were quite vague and needed to be explained. This made it necessary to change some of them or to add a comment for further specification. For this task, it would be suitable if participants change their own contribution or add a comment to it by themselves during the discussion. This is especially helpful if they become aware of possible misunderstandings. Since this was not supported by the web interface, the facilitator had to add changes or comments by himself. He considered this to be quite awkward since he had to use a keyboard to do the necessary typing. However, it is not trivial to find an appropriate design for an interaction mode which supports users to enhance their own contributions – it is not reasonable to generally allow users to submit large text items since this is not feasible for the ongoing procedure. It may be disturbing if users change or enlarge their contributions while the facilitator is working with them or tries to focus the participants' attention on another part of the process.

4. Gathering the contributions as graphical elements made the post-processing considerably easier

Before the workshop started we doubted that the participants would be quickly able to verify whether their text based contributions (on the web interface) were successfully transferred into graphical elements on the large screen. According to our observations the participants did not try to do this verification very often. It is however important that the contributed elements remain readable from a distance if the participants decide to do this verification, which requires a suitable font size.

5. The production blocking effect could successfully be avoided

By enabling parallel contributions through the web interface, the participants were no longer forced to wait and thus not negatively affected by the contributions of others as they could stay focused on the web interface. The web interface provided all necessary information like the brainstorming question and the participant's own contributions. It even provided the information that a participant's contribution had been conveyed by displaying a tick in front of it (see Figure 4). According to the observed behavior of the participants and to the self-awareness of the observer, the contributions of others did not necessarily have negative effects on each other, but probably served as a prompt for the participants to foster their creativity. It caused them to rethink their original idea and to come up with a more suitable or even completely new one. When a participant felt the need for further inspiration s/he could pay attention to the contributions of others by looking at the large screen. We were told by the participants that the advantage of our setting was the ability to choose individually whether they wanted to refer to the contributions of others or not. This leads to the assumption that the production blocking effect can be avoided as long as the participants are not forced to pay

attention to the contributions of others. Therefore we decided to conduct a second study which deals with this issue (see section 6).

6. Support of convergence by aligning brainstorming results within a process model

During the clustering phases it worked well to use a process model as a scaffold into which the brainstorming contributions were sorted. It helped to keep the interplay between the different brainstorming areas / process elements in mind while clustering the brainstorming items. In the course of the brainstorming, the model provided further context so that the contributions did not drift too far apart. A relevant question in this context is whether the awareness for the overall process as a scaffold narrows the scope of creativity of provides an effective inspiration.

7. Free choice of brainstorming topics

The brainstorming would gain more flexibility if the participants could freely choose to which part of the model they contribute their items. This free choice could be structured by the facilitator if he has the possibility to indicate those parts of the model that can be selected as brainstorming areas at a certain moment. Furthermore, the participants should freely decide whether they individually continue the ideation phase while other participants have already started to cluster ideas or to transfer them into a process structure.

6. Study 2 - Evaluating the effects of awareness on creative process design

On the basis of the first case study we improved our tool and designed a second case study. It consisted of three workshop sessions, in which we applied and evaluated both

an improved process modeling brainstorming tool and an adapted strategy for the facilitation of and collaboration in the workshops. The workshop sessions had the purpose to get a better understanding of the effects of awareness in the course of collocated brainstorming sessions. It should be noted that we intentionally did not conduct statistically controlled experiments but pursued an explorative approach to get insights into the following questions in the context of collocated ideation workshops:

- How does direct awareness of the contributions of others affect ideation?
- How do discussions among participants affect ideation?
- How far does the orientation on a process structure provide a scaffold – or a limitation – for ideation?

In the following section (6.1) we will describe how we improved the technical infrastructure in order to meet the requirements for this study. Afterwards, we will describe how the study was designed and conducted (6.2) before presenting results derived from it (6.3).

6.1 Improvement and preparation of the tool

During the course of this section we will describe how we pursued the further development of the software after analyzing the first case study. This analysis led to several evidences for improvement. We however focused development on the following requirements that are necessary for the conduction of the second study:

1. Allow free choice of contribution to multiple brainstorming topics

One major requirement for the second case study was that it should be possible to include multiple brainstorming topics in the same model. Furthermore, every participant should be able to freely switch between the different topics (c.f. result 7 in section 5.1). This requirement however could not be established easily, as the previous interface provided a history that is visible all the time to provide individual awareness for each participant. As the history should be related to the corresponding brainstorming area in order for the participants to find their own contributions more easily, the design of the web interface needed a complete rethink.

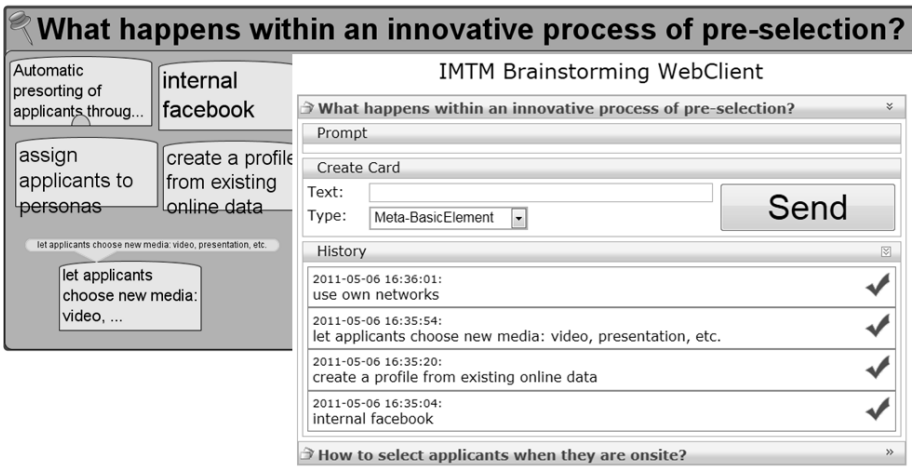

Figure 5. A brainstorming area in the facilitator interface (left) and the corresponding web interface for the participants (right)

Another very important aspect of the redesign was that we wanted to maintain an easy overview for the participants over all available brainstorming topics. So we decided to create an interface where all available brainstorming areas are visualized all the time, while the individual history is initially hidden but can easily be accessed if necessary (c.f. Figure 5). This also may have a considerable impact on the awareness

of the contributions of other participants. In order to assure that a contribution has been captured, each participant either has to search for it on the large screen or to open the corresponding history with a single click on the web interface. This supports the second study as we want to observe the effect of the contributions of others on ideation.

2. Provide a suitable facilitator interface

One prerequisite for our study was that the facilitator interface should be as easy and seamlessly to handle as possible. We wanted to enable the facilitator to focus on the management of the communication while still providing means to flexibly adapt brainstorming topics as s/he feels necessary. This leads to the new function for easily creating multiple brainstorming areas in one model: selecting a certain tool and dragging the cursor to the desired destination creates a brainstorming area anywhere inside the model. In addition, the tools allows for the creation of a brainstorming area around an existing element. Furthermore, the facilitator can now move multiple elements at one time by selecting them and then simply dragging them to the desired destination. This is supposed to simplify the post-processing and to improve the flexibility when clustering (c.f. results 2 and 4 in section 5.1).

3. Allow longer contributions while maintaining visibility from a distance

In addition to providing multiple brainstorming areas we also wanted to allow the contributions to be longer (c.f. result 3 in section 5.1). This is another requirement from our first study, as participants sometimes felt the desire to explain their contributions more thoroughly. However, as we wanted to maintain visibility from a distance as well as to keep the contributions manageable for the facilitator, the display of contributions is still limited to a few words. The complete contribution is put into a comment that is attached to the corresponding element and hidden initially (c.f. gray half circle at the

top left element in Figure 5). This comment may easily be shown by the facilitator on demand (c.f. bubble at the bottom left element in Figure 5).

6.2 Design of the study

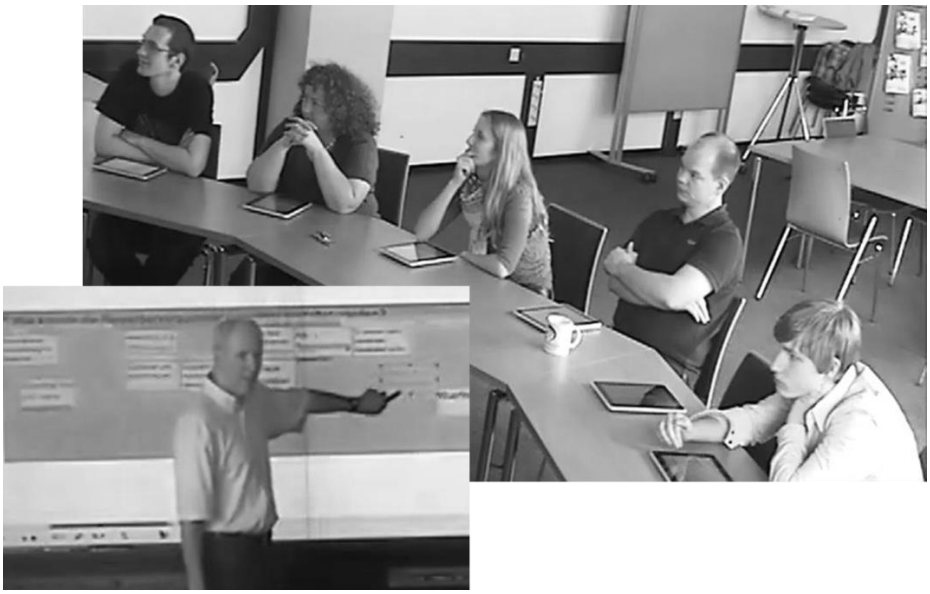

Figure 6. The facilitator working on the interactive large screen (bottom-left) while the participants are waiting to start contributing with their iPads

We developed a workshop setting for four to six participants to collaboratively develop a process for the selection of job applicants in a business or academic setting. The sessions were run in our ModLab (section 4.1), where the improved software prototype (c.f. section 6.1) was used on the interactive large screen and wireless devices used by the participants (see Figure 6 and section 6.3.2 for details). We conducted three sessions with a total of thirteen different participants (four participants in the first and second session, five in the last one), who were all familiar with the environment and

equipment used. Most of them were also knowledgeable of applicant selection processes, as they had either organized or at least taken part in one.

In preparation of the workshop we created an initial visualization of two brainstorming areas and an overall, comprehensive brainstorming question (c.f. Figure 7): “Which activities are needed for an innovative process of selecting applicants?”

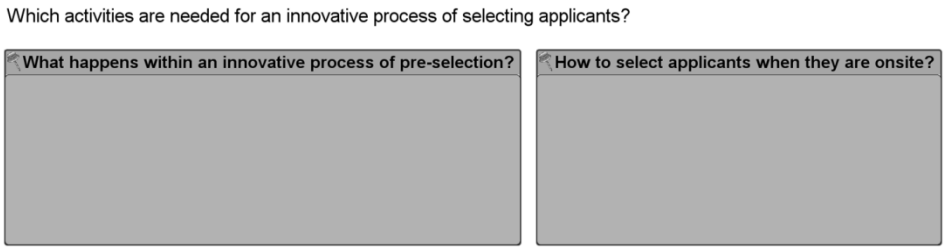

Figure 7. Setting for the second case study (two empty brainstorming areas)

Additionally, each of the two brainstorming areas contained a brainstorming question, the first one being: “What happens within an innovative process of pre-selection?” It aimed specifically at a selection process that is supposed to deal with many applicants in a short period of time. The second brainstorming question was “How to select applicants when they are onsite?” and aimed at a collocated selection process of those participants that have passed the initial pre-selection. We divided the process into these two phases in order to provide additional structure for ideation and to support the clustering process afterwards which aimed at building a sequence among the contributions.

Each workshop was divided into four phases (c.f. Table 2) with an initial explanation of the setting, where we told the participants that we were searching for ideas on how to conduct an innovative process for the selection of applicants. They were also told that they were allowed to contribute to each of the two brainstorming areas at any time throughout the whole session. After this explanation, we asked the participants to start

contributing and gave them access to the web interface to contribute ideas (c.f. bottom right in Figure 5), which they could use by wireless devices available to them (see section 6.3.2 for details on devices used). This phase lasted for about five to eight minutes, while we left it to the facilitator to decide whether or not the participants were still productive and to stop ideation. During this phase we observed actions of participants and noted e.g. whether, when and how long they were looking at the large screen or if they focused on the input screen on their device.

Table 2. Design of the workshops for the second study

Phase	Observation goal	Participant task	Time
1	Effects of the contributions of others on ideation	Individual ideation through a web interface on a personal device while casually watching the large screen	5 - 8 minutes
2	Effects of discussion and process orientation on ideation	Sequence and content related clustering of the contributions with parallel contribution of new ideas	45 minutes
3	Ensuring that last-minute-ideas are captured as well	Individual ideation through a web interface on a personal device while casually watching the large screen	5 minutes
4	Gathering the view of the participants	Elaborating about the individual view on the previous activities	5 - 10 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 selection process for applicants. Additionally, the facilitator told the participants that they were free to contribute additional ideas any time during the clustering process.

After finishing the clustering we gave the participants a final opportunity to provide further contributions in another brainstorming phase of about 5 minutes.

6.3 Analysis and evaluation

After each workshop, we conducted a semi-structured group interview, asking participants whether they were inspired by the contributions of others during the initial ideation phase. Additionally, we asked them whether the orientation towards the process sequence helped them during ideation in e.g. identifying gaps in the sequence.

In addition to the interviews we also videotaped each workshop from three different angles, in order to detect awareness driven switches that were not articulated by the workshop participants during the interviews. Furthermore the contribution history of each device – including the wireless devices and the interactive large screen – was captured for analysis. Additionally, we had two observers, one observing the glance of the participants towards the large screen – especially during the initial ideation phase – and another one sitting in the back in order to perceive the overall course of actions as well as reactions to facilitation influences such as additional prompts. All of these different data sources were combined in order to form a complete picture of all awareness driven switches that occurred.

After gathering the aforementioned data we jointly analyzed the material with respect to switches of awareness. Within this analysis, the observational data was used to find occurrences of switches within the videotaped material thus identifying the context in which it occurred. We paid special attention to the effects of different interventions that we facilitated during ideation. These interventions were e.g. the continuous display of all contributions and the sequence related clustering.

6.3.1 Observable patterns of awareness driven switches of attention

To understand the reciprocal dependencies between awareness and ideation we identified the occurring patterns of switching attention. We consider every situation in which the participant´s awareness of their context let them move the focus of their attention as such a switch.

1) Sometimes the participants just looked around the room; their attention was not caught by what is displayed on the large screen. It seemed that they only sought distraction while waiting that something is coming into their mind which could be contributed to the brainstorming. However, this glancing around is an opportunity to become aware of how active the rest of the group is. This kind of looking around could already be observed before a participant has entered a first contribution and it was only shown by some of the participants and mainly occurred in the earlier phase of the brainstorming
2) Some participants stopped entering their own ideas from time to time and started reading the contribution of others, which were displayed at the large screen. Afterwards they switched back to their work. This behavior occurred more often at the end of the initial brainstorming.
3) Participants did not only look on the large screen but also around the other participants, assumingly to see whether they are already, or still, active.

After the initial brainstorming the participants were mainly focused on the communication with the facilitator. During this period we also observed characteristic behavior:

1) In only a few situations, participants moved their attention away from items the facilitator was dealing with to other parts of the displayed contributions currently not being discussed. Probably they did so because they were looking to related issues or just searching for the spot where their own contributions were displayed.
2) During the discussion they switched their concentration between the interactive wall and the participants who were speaking or listening. We assume that the participants also were watching the non-verbal behavior of the members of the group.
3) From time to time, participants moved their point of view back to the input device. Afterwards they either started to write something or they switched back to the ongoing discussion. The second case is especially interesting since we do not exactly know the purpose of looking back to the iPad or laptop. Maybe these participants wanted to start writing something but did not succeed in doing so, or they just tried to make a break to follow their own ideas or to allow themselves a rest. In the third session we observed a woman – Y – who started three times to interact with the input interface during the discussion, but did not go on and re-focused on the group's communication. Only at the forth try she entered a new contribution.

6.3.2 Relation between awareness and ideation

By analyzing the data of our observation we were able to derive suggestions for the relationship between the awareness for other's activities or for the content of their contributions and the participants' productivity of ideation.

During the first phase of brainstorming the following interdependencies can be suggested:

1) Participants just had a short glance to be sure that their contributions are transferred to the interactive wall.
2) Some waited between 3 to 5 minutes before they started to enter contributions. In some cases it looked like as if they needed an inspiration by what others have contributed. Thus, they first looked at the large screen and afterwards entered an idea.
3) Some participants were directed to another aspect of the process model by reading others' contributions. One person (K) started with entering activities which actually take place before an application is submitted ("providing information for potential applicants"). Afterwards he switched to the other topic (onsite selection) which was displayed at the right side (see Figure 7). Afterwards his point of view moved from the iPad to the large screen and he read the contributions which had been collected on the left side of the screen (pre-selection). Then he went on with entering ideas, but now concerning the core of preselecting ("Comparing of the profiles"). We assumed that this switch had been triggered by reading what others have entered.

For the phase of facilitated discussion, clustering and sequencing of the collected items, we expected that the participants would go on in providing contributions, as we offered them the technical solution to do so and had told them at the beginning that this behavior was highly appreciated. One group (group 1), which had a vivid discussion, did well with respect to this expectation: one person just went on with entering ideas (after 2 minutes) and the second person joined in doing so after 7 more minutes. Thus, we assume:

1) that the questions and statements which came up during the discussion were a source of inspiration for the ongoing ideation,
2) and that at least the most active participant was not reluctant to switch his attention away from the ongoing discussion to using the iPad for writing down a new idea – still having awareness for the group's communication via hearing what is said.

However, our experience with the second group (group 2) revealed that it can also happen that participants are not willing to mix group discussion with generating and entering new ideas. As a consequence, the facilitator provided an increased number of prompts in the third session, repeatedly telling the participants during the discussion that it is appreciated to go on with entering new ideas. However, these impulses did not lead to the intended effect. Immediately after some of this prompts Y looked at her iPad as if she wanted to start writing something. Then she heard something being said by another group member and switched her attention back to the discussion. Obviously, the auditory awareness for the ongoing communication prevented her to enter new items. Only after 14 minutes the first participant – M – entered an additional idea. That happened immediately when a short break was caused since the facilitator had announced to move to the second brainstorming area (onsite selection) at the left side of the interactive wall.

When the newly entered idea appeared on the large screen this was perceived as an impulse by the other participants, who then also started to enter new contributions. Obviously, the behavior of others has a decisive influence on the decision whether one starts with entering additional contributions. It is remarkable that it was not the observable actions of M typing the idea which inspired Y to enter an item. Although she was

directly sitting beside M she did not realize what he was doing. Only after M's contribution popped up at the screen, Y became aware of it and started writing.

Furthermore, it appears more reasonable if the facilitator does not only explicitly ask the participants to go on with entering ideas in the course of the discussion but inserts short breaks where such a behavior can start. It turned out to be helpful if the clusters which are arranged by the facilitator leave empty space so that the participants see where further ideas need to be filled in. The best prompt for going on with the ideation seems to be the behavior of others – if there is a very active participant or an icebreaker who is the first with making contributions during the discussion, the others will follow.

Considering communication among the participants, in the three sessions we found the groups to differ significantly with regard to the amount of communication during the clustering and item explanation phase. Without a difference in facilitation in the three workshop sessions, one group (group 1) engaged in intensive discussion of certain items, while the others either discussed less (group 2) or hardly discussed anything and only had short and mostly bilateral conversations to e.g. understand items better (group 3). What is striking in this context is that the discussion group (group 1) also contributed more items during the clustering phase than the others did. In this group, they also asked each other to add items in order to document ideas created during the discussion or other aspects as a result of it. In the groups 2 and 3, mostly only one participant was talking about her/his item, which sometimes caused others to get bored or distracted and even show this by their body language. Based on this observation, we assume a relationship between the communicative engagement of a group and, by this, the discussion about items and the ideation happening – in other words, communicative interaction may have a positive influence on ideation by keeping brainstorming participants

mentally focused and involved in ideation. Moreover, we had the impression that discussions during this phase led to increased awareness for relations between items and the process they were to form, as participants from the discussion group also contributed more items specifying or altering existing ones as well as items bridging gaps in the process. Considering these observations, we propose to regularly prompt brainstorming participants to comment on other items and engage in corresponding discussions – this could be done by a facilitator. In addition, tools for the input and manipulation of items such as our brainstorming interface and the large screen should randomly show dialogues including input fields, which prompt and allow users to comment on others' items.

In this context, there is an interesting difference between the perception stemming from observing the workshops and the perception participants articulated. When we asked group 1 what helped them and what hindered them to create items during clustering, they told us that communication might have distracted them providing items. This, however, is in contrast to our observations described above. Therefore, we assume that an ideal setting of collaborative process brainstorming should contain phases of discussion in order to contextualize items and provoke ideation and individual work allowing participants to focus on ideation in silence and without distractions. From our observations, we propose to intentionally and frequently switch between such phases.

For the observation of influences by changes of the workshop setting, in each workshop session, we varied the constraints of the sessions with respect to technical equipment for item input and the spatial arrangement of participants: In the first and third session, participants used tablet devices (Apple iPads) for input, while in the second session they were given laptop computers. In the first and third session, we arranged

the tables in a light circle, thus provoking visual contact among the participants, and in the second group we placed tables in a row, disabling direct visual contact. While we initially thought that laptops would be more convenient and could be used more concurrently due to people's ability to listen and type in parallel, the iPad groups both engaged in more intensive ideation during the clustering phase – there were no significant differences in the initial brainstorming phase, though. In the setting with the laptops, we even saw three of four participants not using the device (and with it, the input interface) for such a long time that the screensaver came up on their respective screens. This indicates that there are characteristics of the touch and tablet devices that could provoke more frequent usage and, by this, more ideation. For the iPad devices, we assume that they are more attractive to use than laptops, and that their mobility (resting them on a table, using them on the lap or holding them in the hands) is more suitable for brainstorming sessions, as people can still use the input interface even if they are e.g. leaning back to think. In addition to our assumption on the effects of equipment, we assumed that having people see each other during the first two workshops would cause them to provide more items. Indeed, we observed that in the second group, who sat in a row, people provided hardly any items during the phase of clustering. From this observation, we assume that establishing visual contact among participants in brainstorming session can encourage active participation. Summing up, our observations indicate positive influence of device mobility and group awareness in brainstorming session and thus, we propose to take this into account when designing brainstorming sessions.

6.3.3 Effects of process orientation on the creative process

In total, we did not see much influence of process orientation, but we know that we also did not put much emphasis on this during the workshops – in other words, people were not aware of the focus on processes and thus did not act as if they were engaged in creating sequences. Instead, people felt like in free brainstorming and did not seem to perceive it as their tasks to create a whole and interconnected process.

All in all we expected the focus on sequence building during the clustering process to show a more profound impact on ideation. We expected this impact according to the following aspects:

- **Completing sequences:** We assumed that aligning the contributions according to the process sequence would reveal gaps, which then cause the participants to fill them. However we did not see many contributions completing sequences, it only happened two times. In these occasions however the facilitator intentionally prompted the participants to fill them by asking them about the process sequence. Furthermore he intentionally left wide gaps in the alignment of the contributions. However facilitation during the whole study was done in a way to go through items and ask which position in the process parts (start to end) they belong to, and to then shift them to their designated position. This way, the area of the currently focused contribution changed constantly, which might have distracted participants to be inspired by the process sequence in their ideation.
- **Establishing parallel sequences:** During the clustering of items an effect already present in the first workshop could also be observed: for some

items parallel sequences of the resulting process were created, as people could not be aware of the overall resulting process yet and thus could not determine the final positions of certain items. Stronger focus on the construction of a comprehensible process frame from the start could have enabled people to provide whole sequences of action and to better determine a sequence of existing contributions.

- **Adding details to process steps:** Our assumption was that the combination of items into more comprehensive clusters would cause people to detail them (e.g. if a cluster only contains a few items, people would like in order to have the same level of details as in other clusters). This effect was hardly visible and clustering was only done in two of the sessions. Instead of content related clustering, we used a metaphor of temporal arrangement of items, which produced implicit clusters made up by spatial proximity. This, however, did not cause people to provide details. Details – according to our observations – were rather prompted by content related discussion about certain contributions.
- **Proposing alternatives:** Just like in the previous effect, a lot of items provided turned out to be alternatives prompted by content related discussion. They either differed in detail or were complete opposites of existing items.

One reasons for the incompleteness of sequences, clusters or process steps, was the orientation on creating an initial process that was not meant to be complete. This orientation was intended to leave space for ideas, but also may have caused an attitude

that it was not important to complete the details of the process. Another issue to be taken into account is that the session topic was a process the participants were familiar with but not directly affected by. If the latter had been the case, participants most probably would have added more items to e.g. complete sequences in order to have all the tasks they are working in included in the model and to have their work and responsibilities represented in it. We expect this due to experiences in participatory modeling as described in section 3.

7. Conclusions: Recommendations and Technical Requirements

The empirical basis of our research consists of two studies both including a series of workshops in the context of continuous improvement of socio-technical design including the method of facilitation and the technical features of brainstorming tools. When needed, the observations from workshops were completed by interviews with the participants. Therefore, the methodology is clearly explorative and the value of the results is to explain which features of electronic brainstorming can be important for collaborative process modeling and should be taken into account for the development and testing of further prototypes.

From the analysis of our case study, we derived a number of recommendations and requirements which should be met by the combination of tools and a facilitation method employed in similar workshops. The most important requirement is that brainstorming tools should be seamlessly integrated into process modeling tools. The contributed brainstorming items should immediately appear as one of the basic elements of the modeling notation. This has the advantage that all kinds of functions to relate and cluster elements of the model can immediately be applied on the collected brainstorming

results. Sometimes – also in our case study – it can be cognitively disturbing to decide which element-type might be appropriate for the representation of a brainstorming contribution. Therefore the participants must have the choice to use a neutral element which is later converted into a meaningful symbol of the modeling language.

It is reasonable to combine a large interactive touch screen with laptops or other small input devices. While the input devices are used to collect the brainstorming contributions, the large screen is mainly useful to allow the facilitator a smooth interaction with the participants and with the graphical model itself (e.g. by highlighting elements, indicating places where a new element should be inserted, changing the location of elements etc.). With the possibilities of an interactive large screen it is much easier to bring the complete collection of process items as well as the emerging of the whole process model to the participants' attention.

The tools for collecting the brainstorming input should be as simple as possible and be offered as a web-interface. This enables any kind of portable device like laptops or smart phones with a web-browser – to which the participants are used to – to be employed without any preceding configuration work.

The input interface should include the following features:

1) It should be possible to switch easily between several brainstorming topics (where each one represents a brainstorming question) to make an input. The ThinkLets-approach as presented in Briggs and de Vreede (2009) describes a set of partially possible variations for brainstorming sessions during collaborative modeling.
2) It is reasonable that brainstorming results can be completed after the facilitator has already started to work with the collected items. Therefore, the possibility of en-

tering brainstorming items can be enhanced by further means of contributing textual elements which complete the oral contributions during the facilitated discussion:

   a. Participants should be able to add comments to their contributions if it turns out that they have not really been understood by other stakeholders in the workshop.
   b. Participants should be able to support the modeler e.g. by typing (instead of telling somebody to change the name of an element one could propose this by entering the new name immediately by oneself).
   c. They should be able to add new items or comments to the element which has currently been activated at the large screen by the facilitator
   d. It should be possible to mark those items of the history list of their contributions which are related to the item being currently under discussion. Subsequently, this relationship can be displayed at the large screen.
   e. These features will be a signal for the participants that it is okay and appreciated if they switch between being involved in the discussion and making written additions.

3) The feedback on the participants' interface should be enhanced, e.g. by statistics about the contributions of others; by comparing their own contributions with those of others; by indicating similarities between contributions; etc. These features may help to increase the awareness for the relevance of the own contributions or give an impulse to increase the number of own proposals.
4) Inactive users could be triggered – e.g. by a pop-up hint – to move their attention towards the ideas of others which are presented on the large screen.

The facilitator should have more possibilities to change the questions or prompts which s/he gives to support the ideation process. Brainstorming questions or criteria for the type of answers requested should be easy to vary – either by preparing a controlled variation of prompts or by changing them ad-hoc. It could be observed that it is sometimes difficult for the participants to pay attention to the items which are already collected during a brainstorming, since single items disappear in the cloud of a larger number of contributions. This could be overcome by giving the facilitator the possibility to zoom to certain items possibly serving as inspiring examples. This can be considered as a feature which directs the awareness of the contributors. Another example of this kind is the possibility to mark those areas of the process model – e.g. by a certain color – which should be completed.

Another aspect of improvement is the organizational side of the socio-technical solution: The facilitator should not only repeatedly verbalize that additional contributions are welcomed during the discussion but include short breaks from time to time during which these contributions can be written. Since the role of an ‘icebreaker’, who starts to enter new ideas while the group is discussing, has proved as useful, it may be helpful to prepare one of the participants to play this role.

Usually brainstorming and the clustering of the results are separated as phases of divergence vs. convergence (Herrmann 2010). However with electronic support of collaborative process modeling the separation of these phases becomes obsolete and can be replaced by a flexible transitions between both modes: It is reasonable to test features which enable the participants to associate their own brainstorming items immediately with the contributions of others or to add new brainstorming results after the process-oriented clustering and structuring of the collected contributions has already started.

However the merging of divergence and convergence needs increased awareness support. Participants can benefit from awareness about what is going on while they think in solitude on their own contributions. It became evident that the distribution of information between input interfaces and a public large screen supports the users to maintain a kind of unobtrusive awareness which does not necessarily disturb their creative flow. Further features of awareness support in this context have to be developed and evaluated. For example, the facilitator and those who help him or her to sort brainstorming items according to a linear process structure must be aware of new contributions which are added on the fly by the participants. Since process diagrams can be very large, it is difficult to realize that new information is added or existing items are change by their originators – even during co-located meetings. New, unobtrusive awareness features are needed to overcome these difficulties. Furthermore, it is important to evaluate how far the socio-technical solutions for creative process design can also be applied to other areas of design where it might be reasonable to combine linear walkthroughs with creative ideation as well as a work in solitude with collaborative discourses.

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[i] http://www.mindmeister.de
[ii] visit http://www.seeme-imtm.de for more information