Rambla: Supporting Collaborative Group Creativity For the Purpose of Concept Generation

Johann Sell and Niels Pinkwart

Humboldt-Universität zu Berlin, Department of Informatics
Unter den Linden 6, 10099 Berlin, Germany
{sell,pinkwart}@informatik.hu-berlin.de
https://cses.informatik.hu-berlin.de/

Abstract. Asynchronous participation in volunteering social systems is mainly based on various communication and collaboration tools. Supporting creativity in such groups during the process of concept generation is one major challenge to reach high quality working results. This paper presents a collaboration tool supporting the creative process of concept generation. The solution focuses the support of a concrete social system with loose structures and that aims open participation, as discussed in a case study. At the end, the paper shows an evaluation of the solution itself with regards to the described social system.

Keywords: socio-technical system, collaboration, creativity, concept generation, loosely structured social systems, open participation

1 Introduction and Motivation

Ideas, the results of creative cognitive processes of individuals, are volatile and difficult to communicate. These problems are even more important if the context of the creative cognitive process is a collaborative working process that uses the resulting idea. The communication of ideas inside a collaborative working process is a crucial step to archive the shared goal [1, 10]. What can be done to record an idea in that way every person in the group could understand it? A common solution is the creation of a concept that expresses the idea.

While there are a lot of tools supporting such a creation of concepts for professional business organisations as shown in section 3, there exists less research with regards to loosely structured voluntary organisations as mentioned in section 2. So, the presented work will focus such organisations and introduces characteristics of them that have to be considered, if a support for collaboration has to be designed.

Furthermore, this paper shows how to develop a tool supporting the collaborative process of concept generation for such organizations. The developed tool will also try to help reaching high quality for the created concepts. The results of a socio-technical walkthrough (STWT) motivated the technical system [8]. The

Workshop was held to analyse the working processes of the non-governmental organisation Viva con Agua de St. Pauli e.V. that is mainly based on volunteering. The STWT itself will not be presented here, but the work shown in this paper is based on its outcomes. The results of the STWT are asserting that missing or insufficiently described formalized concepts are a main reason for unsuccessfully realized ideas. So, it is an important issue for the organisation to support the voluntaries in the creation of well-described concepts. This can be done by the design of an appropriate support tool.

The next section describes a case study that the results of this paper are based on. That will be followed a presentation of the state of the art for the support of creativity and concept generation in a collaborative setting. The requirements section describes a possible solution for the above-mentioned issue. Afterwards, the implementation of the system Rambla will be shown that fulfils the requirements. Finally, the results of an evaluation and the open possibilities for future research will be sketched.

2 Case Study

The non-profit association Viva con Agua mainly based on volunteering. A decentralized network of local units organizes the voluntary people. The organisation describes itself as "a network of people and organisations commit[t]ed to establish access to clean drinking water and basic sanitation for all humans worldwide."[1] This aim should be achieved by the generation of awareness for the issues Water, Sanitation and Hygiene (WASH) using creative and joyful activities. In the end, this characterisation of the activities provides an adequate explanation for the rapid growth of the social system. Starting at the mid of the 2000s with few volunteering people, currently there are more than 12,000 volunteers.

Such a huge network of decentralized units requires a lot of self-regulated coordination and communication to ensure the creative character of the activities, but also to guarantee the conformance to the legal requirements. Focusing young adults for volunteering, the organisation becomes a magnet for digital natives using various software products to coordinate themselves. Additionally, the social system of Viva con Agua defined itself as very open in participation. That means it is possible to decide to get oneself involved in some activity this day and to veer away from it the next day. Following this the social system describes itself as based on flat hierarchies. So, implementing complex hierarchies in the social system can not solve the problem of self-coordination, as it is often done by companies which expanded in such a way. These were the major motivations for the association to implement a central coordination tool, named "Pool".

This technical system helps some specific recurring tasks and the social system uses it in a way that can be described as a socio-technical organisation in the meaning of Kunau [11], but it has no support for creative activities. Furthermore,

[1] `http://www.vivaconagua.org/home`, visited on 2016-05-02

there is no communication support implemented yet. These circumstances motivated the young volunteering digital natives to try a lot of third-party products during their working processes. Such approaches mostly failed, because some tasks, roles and aspects like the open participation of the social system were not taken into account (cf. [11]). Furthermore, during the development of a technical component for such a socio-technical organisation it is important to prevent cognitive overload, because the users are volunteers. For the process of adoption this could be crucial, because not only the users are volunteers, but also their usage of the system is by choice. Additionally, a high cognitive load will impede the participation by new members.

As mentioned before, companies and other close structured organisations, like institutions of education, establish complex social systems and their collaboration systems have to consider these circumstances. So, there is little applicable support for organisations like Viva con Agua. That was the reason why the organisation started a collaboration with the Humboldt-Universtät zu Berlin in 2014 using STWTs to survey requirements for technical systems supporting the social character of Viva con Agua. The results of the first of these workshops are the base for the requirements of the collaboration tool given in section 4.

3 Related Work

Next the basic terminology will be explained, followed by models of the creative process and identified problems of the creative (group) task. Subsequently, a subsection presents established support methods and some tools to give an overview of the state of art. Each subsection focuses the support of loose structured organisations during the creative group process of collaborative concept generation.

Also it will be interesting to take a look at argumentation support and try to adopt elements of methods like IBIS [12] or tools like GRADD [3] or ArguMed [18]. These methods and tools are mainly based on explicitly modelling the argumentation inside the users' input. Regarding their diversity of expression, volunteers will probably run into cognitive overload, so these methods and tools can not be used considering the conditions described in section 2.

3.1 Terminology

It is hard to define the widely spread term "concept", because it is often used in different contexts and integrated into the everyday speech. So, for the following explanations, a concept will be defined as a structured presentation of all aspects of an idea. These aspects can be understood as sub-ideas, following the same goals as the main-idea, but imply some concrete effects. For example: If someone has the idea to inform people about the concept of "virtual water" on a special event, the kind of information, the use of special material or some entertainment would be possible aspects. So, the term concept does not mean the mental representation of the idea as often used by cognitive science, but

a special form of externalization of the idea. This externalization serves as a possible communication base between people.

Supporting the collaborative and creative process of concept generation requires a clear comprehension of creativity. Csikszentmihalyi [6], Asimov [2] and Herrmann with regards to Sternberg [9, 17] can be summarized by the following characterisation of the term: Creativity is the "...ability to produce work that is novel ... and appropriate..." [17]. The social context of the idea evaluates its novelty and appropriation [9]. Csikszentmihalyi complements that such a common evaluation is often influenced by individual expert assessments [6]. Additionally, Csikszentmihalyi and Asimov [2] recognize that really novel and appropriate results are mostly outcomes of so-called collaborative creativity. This means a group of people, following their individual creative processes, share their individual results. This way the members could increase the knowledge base of the whole group and stimulate effects of synergy. One group member can come up with a novel and appropriate result that would not be possible without the results of creativity of the other group members.

Such an understanding of creativity will also match the "search for ideas in associative memory" (SIAM) model [15]. The model describes the creative process as based on a set of ideas inside people's memory. During the process only those ideas with a strong relation to the current thoughts are activated. If multiple ideas became active, the resulting thought will be creative, if the ideas were loosely or not linked before. Also Link et al. [13] recognize that the definition of creativity given above implies the possibility to evaluate a tangible result of the creative process. The next section will give an understanding of the structure of creative processes.

3.2 Creative Processes

Liu et al. describe different phases of the creative process [14]. They distinguish between divergent and convergent working steps. There are many other possible descriptions for the creative process, but the one mentioned by Liu et al. is commonly used [9]. The divergent working steps produce a huge number of concept alternatives, while creative people merge or sort out some concepts during the convergent steps. Liu et al. aimed to support the creation of promising concepts. On the one hand, this implies the generation of a huge amount of concept alternatives to prevent overlooking a valuable possibility. On the other hand, such a huge amount of concept alternatives reduces the clarity. It becomes harder to recognize valuable concept alternatives and also to evaluate and select some of them. So, next to the creation of a huge amount of concepts, the generated set has to be held manageable.

Herrmann describes four characteristics of creative processes [9]: playfulness, iteration, back and forth considerations and "aha-moments". Due to the fact that creative processes should produce novel ideas, some free space is needed to follow extraordinary thoughts. This is meant by the term playfulness. Iteration is important for walking on and going back between the phases. Additionally, forward considerations allow to refine thoughts during the creative process. Also

creative people can do a consideration backwards, if they identify ideas as not novel or not appropriate. Results of creative processes are often marked by moments of realization, if the creative person appreciates the new insight. This is called "aha-moment".

Next to phases and process descriptions, some characteristics of the social system have to be mentioned, which are required for an effective and creative collaboration. Asimov noticed the importance of a relaxed and open-minded social context [2]. Herrmann pointed out that a consensus has to be built up inside the collaborative group to change the current working phase [9]. Additionally, he mentioned that creative thoughts are often very complex and so it is hard to communicate them. The main problems that motivated this work and that were introduced in section 1 are very similar to this one. Herrmann noticed that this kind of problem will arise more frequently in distributed collaboration.

3.3 Existing Support Methods

In this subsection some established approaches and methods supporting goal-oriented creative working procedures will be presented that are based on the understanding of creative processes given above.

Liu et al. introduce an approach to work in a creative manner for concept generation in their work. As anticipated, they described a divergent phase followed by a convergent one. These phases consists of different working steps which could also be classified as divergent or convergent. Furthermore, they decided to follow the idea of multiple layers of abstraction. This implies that a result of the creative process of concept generation will be reached by a step-by-step detailing of the concept alternatives. The innovation described by the approach of Liu is the ordering and weighting of the working steps. Both are defined by the current phase of the creative process. That means, during the divergent phase the corresponding working steps will be followed by a quick convergent step to keep the set of concept alternatives small. Also, for the convergent phase quick divergent working steps will precede the convergent ones.

Another method of concept generation is called "KJ-Method". Yuizono et al. use this method to order a chaotic mass of information [19]. It aims at the generation of ideas and a following transformation of them into concepts. Additionally, the engaged people always work in a cooperative manner. The "KJ-Method" consists of four steps. At first, all participants are suggesting ideas using so called "tags" (a small chit of paper could be used), which are placed on a shared desk. The participants place their "tags" at the same time. This will be repeated multiple times, so the suggestions can inspire other group members. Next, the ideas will be grouped into "islands". This is done during a discussion of the similarity of the "tags". Afterwards, the participants create relations between the islands and as a last step, they write a conclusion.

This methods have influenced the development of several tools, which will be described in the following subsection.

3.4 Tools

The Idea-Thread-Mapper (ITM) developed by Chen et al. [5] has to be considered, because the supported process of enquiry might be equal to creative concept generation. A timeline containing the collaborative working steps of enquiry visualizes the process of knowledge generation. It consists of chronologically-ordered discussion inputs focusing a shared issue. In that way the development of knowledge becomes visible. So, this kind of visualisation helps the users to contextualize their knowledge by using the timeline for asynchronous communication.

Liu et al. also implemented their approach [14] and the resulting system is called "FuncSION". It allows the creation of concepts by the usage of so-called "Building Blocks". These are detailed parts oriented at components as used in their domain mechanics. The composition of such "Building blocks" has to follow given rules that reduces the set of possibilities. Obviously, "FuncSION" follows their approach, if at first a set of alternative concepts will be generated.

Both tools based on the creation of a huge amount of concept alternatives, which will be reduced by procedures of evaluation and merging. Link et al. [13] implemented a system using a more detailed view on ideas. Their approach of an anchored discussion supports the explicit creation of relations between a discussion input and a part of an idea description. The users are able to split an idea during the idea creation process to reduce the complexity, although the authors mentioned the possible problem of missing context, if the users describe the idea only by its different aspects.

The possibilities of supporting creative processes shown above have to be used to extend the existing socio-technical organisation Viva con Agua. The referenced papers exhaustively evaluate all tools and methods, especially the approach of Liu et al.. Mostly the authors have chosen a study setting that forced the participants to use the system in specific working procedure. Additionally, the systems are developed for organisations with a complex structured social system. So, they are not applicable for the purpose of such an organisation of volunteers as described in section 2. The usage of the mentioned methods considering the explained problems and steps during the collaboration will be shown in the next sections, focusing a volunteering organisation.

4 Requirements

The sections 2 and 3 imply that the system has to support a varying set of group members, specially the integration of new members into the working process. Additionally, the open participation requires that it should guide the users to select the correct working steps during the process, instead of supporting some special steps as done by several other tools.

In contrast to the implementation of their approach by Liu et al. [14] the creation of multiple alternatives by the users should be prevented, to reduce the cognitive load as mentioned by Link et al. [13]. The users have not to evaluate and merge different concepts for a following analysis of the details of the resulting concept. Following the guidelines of Herrmann [9], the users can start their

working process by manipulating different details of the concept or with a general discussion of the topic. So, the creation of different alternatives corresponds to the definition of aspects of the idea, instead of the definition of whole concepts. It should be ensured that the discussion will focus on the aspects and their influences into the concept as a central theme. The documentation of influences of aspects can be interpreted as a kind of convergent working phase, while the discussion about the influences and aspects could be described as a divergent phase.

It becomes apparent that the divergent and the convergent phase are intertwined, so it is really important to support communication between the working group members by the system. Additionally, the decentralized character of the social system as mentioned in section 2 implies spatially and temporally asynchronous communication, so the social system also requires a special support of communication by the technical system (Req. R1).

A confusing discussion could result in cognitive overload, as described in section 3. Following this, for the purpose of ordering and sorting discussion input a possibility to assign the input to explicit aspects of the idea should be created (R2). Afterwards, the user could limit the discussion input by the aspects of an idea (R3). This will reduce the cognitive load and helps new people to focus on interesting aspects of the discussion. Such an implementation of functions will also follow Link et al. [13]. Furthermore, the Idea-Thread-Mapper (ITM) [5] recommend an ordering of the discussion input by its creation date (R4).

For the purpose of transforming the contents of the discussion into sketched influences inside the formalized concept, the system will provide the possibility to assign such values at a connection between the concept and the aspect. In this way it will be possible to separate the influences and filter the concept's content (R5). Thus, the system supports the user in getting an overview of the described influences and new users will get easy access, as forced by the social system described in section 2. Additionally, the influences of the aspects can be aggregated automatically to reduce the cognitive load of the users (R6).

With regards to the four characteristics of creative processes identified by Herrmann, specially the iterations and back and forth considerations, the system implements a function to exclude described and formalized influences of aspects from the concept (R7). Such a function will help if users have to remove the described influences, which is an error-prone proceeding. Also, the possibility to re-include such influences will help during forward considerations.

As Herrmann suggested the system should support a dynamic switch between discussion and working on the shared material [9]. This is extra required, because the system should guide the users working like the approach of Liu et al. The first implication will be the parallel visualisation of the discussion and the shared material (R8). Additionally, the system has to allow the user to work inside the discussion, but his / her actions influence the concept and the other way around (R9). A clear, syntactical separation of discussion input, explicit aspects of the idea and the described influences inside the concept should be extra help for the users to keep the overview of the system contents (R10).

The definition of the term "concept" given in subsection 3.1 allows the implementation of a type of concept known in the social system of Viva con Agua. Such a concept will be structured by a set of key-value pairs (R11). A key could be understood as a pair of aspect and influence label, while a value would be the concrete description of an influence affected by the aspect. It follows, that an aspect could have multiple described influences, identified by an influence label. Additionally, all influence labels can be grouped by so-called sections (R12). For the example of section 1, the special event to inform people about the thoughts of "virtual water", it would be possible to describe an influence as labelled by the term "costs" and the value "100 Euro", given by the aspect "entertainment". Secondary, the section "input" could categorize the influence labelled by "costs". Obviously, the different aspects of an idea could be described by a structured set of influences. Such a kind of description will satisfy the definition of the term concept given above. Following the guidelines given by Herrmann in [9], the shared material should always be malleable. So, the affiliated influences and specially their labels have to be an open set. In relation to a function that aggregates all values of a influence label (already mentioned by (R6)), it is required to implement a possibility for the users to dynamically add new influence labels, but also values (R13).

At least, the system needs to be highly accessible, because the social system requires less or no barriers for the integration of new volunteers (R14). There will be users accessing the system multiple times a week and others who will use it only a few times in a year. So, the acceptance of the new technical system by the social system depends intensively on the accessibility of it.

Taking the approach of Liu et al. into account, it seems clear that a divergent phase could be described as a generation of new explicit aspects, which can be generated only by creating discussion input. The system allows the description of influences of such explicit aspects at any time, so it would always be possible to follow a divergent working step of creation of such an aspect by a convergent step. In the end, the users are free to decide whenever they like to describe the influences. The assumption is that the structure of the socio-technical organisation, the communication pattern of the social system in relation to the functions and presentation of the technical system, guides the users to work according to the approach of Liu et al..

The explanations above are relating the social context of the new technical system Rambla to the theory of creativity, collaboration and concept generation. This section has shown the details that have to be considered during the design of the technical system. In the next section the concrete implementation will be sketched and after that an evaluation will be described.

5 Design and Architecture

Following (R14), Rambla is designed as a Rich Internet Application (RIA) [4], accessible via a Uniform Resource Locator (URL) using a modern web browser. Additionally, a broad selection of mobile clients is possible. The technical system

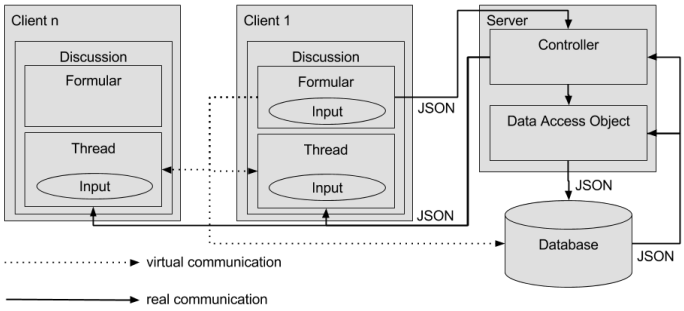

Fig. 1. Virtual communication between the clients for the purpose of sharing one consistent state.

"Pool", introduced in section 2, is also designed as a RIA and already adopted by the social system. So it can be suggested that a RIA implementation has the potential to become adopted.

As described above, the collaboration using Rambla requires a lot of interaction between the user and the shared material. Consequently, the system will produce a high communication ratio between the clients in order to keep the shared material synchronized. For the purpose of preventing blocked states of the system for the users, the communication with remote computers should be reduced to the required ones. So, the client-side is handling the events and inputs at first. Only after detecting the requirement of synchronisation the client will initialize a communication.

For the purpose of implementing the communication between clients as forced by (R1), the central server has to be mentioned, which is implicitly given on a RIA based on HTTP, HTML, CSS and JavaScript. The server always has to reroute the communication. Preventing the effort to create a connection each time a communication has to be done, the system initiates WebSockets. So, if a client system decides to synchronize the results of a user interaction with all other clients, it uses an open WebSocket connection to send the results to the central server. The server uses the WebSocket connections to all other clients to propagate the updates.

Figure 1 shows the realization of the virtual communication, exemplified by the synchronisation of the discussion. The client sends entered input to the server that saves it into the database and supplements it by information unknown to the creating client. The server sends the completed input to all clients, including the creating one. The clients add the new content into the discussion thread, which shows all input in a chronological order.

The client implementation is realized using the JavaScript Framework *react*.[2] This allows to separate the different functions and areas into components and helps during the development process. Particularly, the implementation of a highly reactive user interface using WebSockets becomes manageable by the differed *react* components. The system uses the components in a hierarchical

[2] `https://facebook.github.io/react/index.html`, visited on 2016-04-14

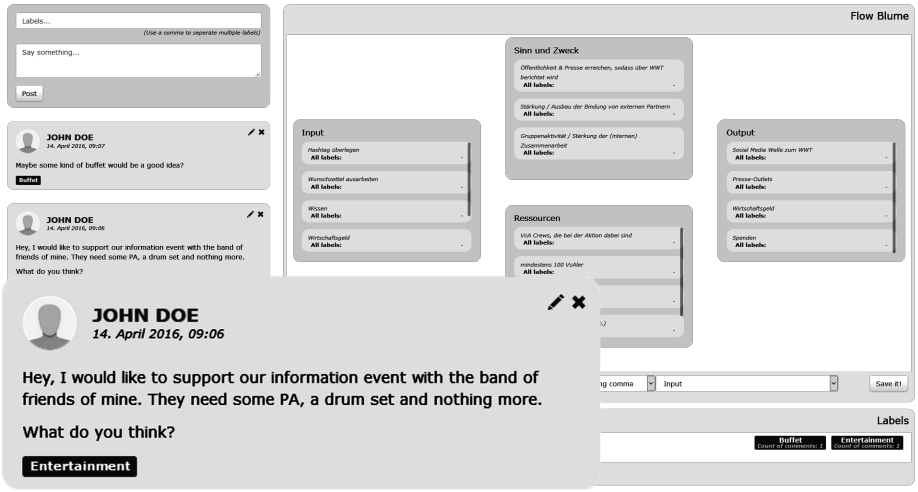

Fig. 2. The user interface of Rambla, showing the layout. For reasons of readability one discussion input is zoomed in.

form, following the composite pattern [7]. Thus, a form and a thread compose a discussion (R1), as shown in figure 1.

Figure 2 presents the user interface of Rambla. The three basic elements, discussion, concept and the set of explicit aspects will be shown using three different components next to each other (R10). While the discussion will use the left side, the concept and the set of explicit aspects will share the right side of the website (R8). The system implements functions for adding, editing and deleting inputs for the discussion (R1) and connects this functions with the equivalents for explicit aspects (R2). Also, discussion input will be ordered by its creation date (R4). Furthermore, it is possible to add new influences by adding a label (R13) at first and assigning a value afterwards (R5). For the latter function the user has to select the label of an influence and an explicitly described aspect. A new form allows to add a value will replace the form at the bottom of the concept. The entered value is saved at the relation between the aspect and the influence label (R11). These labels are grouped by predefined sections (R12).

In addition to the functions described above, it is possible to change the name of aspects and to define if the aspect should be excluded (R7). For this purpose, the user has to select the aspect, which s/he wants to change and a form will be shown in the bottom of the aspects area, which allows the editing.

By the selection of an aspect, the discussion will be shortened to the set of input, which are assigned to the selected aspect (R3). Also the selection of an aspect changes the visualisation of the concept (R9). While by default, the concept shows for each influence label its aggregated value, after the selection of an aspect its special influence will be shown below the aggregated value.

Such a detailed view of influence values can be displayed for all influence labels, by selecting them. A users click on it presents a list, whose items consist

of the aspects name and the specific value given by the aspect. This list will also be shown below the aggregated value. Such an aggregated value of all values described by some aspects is shown inside the concept for every influence label (R6).

6 Evaluation

The following section presents a system's evaluation, showing that the system is implemented in such a way it will motivate the users to work on a process like the approach of Liu et al. [14]. The usage of the approach implies that the working procedure of the users shows the patterns of divergent and convergent working steps as described in subsection 3.3. So, the system exemplifies how to build a technical system supporting a loosely structured organization of volunteers executing the complex task of concept generation.

6.1 Hypothesis and Data Collection

In this paper one hypothesis will be examined, while much more was investigated during the study. The detailed results are available in [16]. Here, the following hypothesis will be analysed: The system is designed in such a way that the users will adopt the approach of Liu et al. without any external assistance. As mentioned in section 4 the social system requires the consideration of this approach for the purpose of adoption and participation of new members. So, this seems to be one major step to integrate the new technical system Rambla into the social system. The set of available functions and its presentation to the user will be investigated by evaluating this hypothesis. This way the evaluation outlines to what extend the system fits the needs of a loosely structured organization performing the task of collaboratively generating concepts.

Focusing on the approach during the development is the base for the given assumption and section 5 shows that the system allows working procedures following that approach. But whether users select the working steps in the right order can only be examined by a qualitative analysis of the users behavior. Additionally, the qualitative analysis will be underpinned by a questionnaire, which is analyzed in a quantitative manner.

The qualitative analysis is based on a chronologically sorted list of logged user actions. These actions were classified as a divergent or convergent activity and the resulting sequences were interpreted in the context of the approach. The system saves every action inside the database to generate a set of data that could be used for this purpose.

Focusing the presented system Rambla, the detailed development and discussion of aspects can be understood as the divergent phase, while the description of the influences of the aspects inside the concept marks the convergent working phase. The divergent steps are the creation and editing of aspects and discussion input. The convergent ones are the assignment of aspects to discussion input, the change of the status of aspects (included or excluded) and the creation of

Table 1. Items of the questionnaire with regards to the evaluated hypothesis.

1	Before I changed the concept, I had reflected about this amendments.
2	The discussion input of other users and their amendments of the concept have not influenced my activities with regards to the system.
3	If I had an idea for the concept, I have always recorded it inside the concept.
4	What I have done inside the system was always based on the actions of other users.
5	I have always discussed a theme, before I reflected about its influences to the concept.
6	If a theme occurred during the discussion, I always noted some possible impacts inside the concept.

influence labels and values. The deletion of aspects and discussion input can also be described as a kind of convergent step, but this would imply that the function of exclusion for aspects is not being used. So, it is case-sensitive to decide if an activity of deletion will be a divergent or convergent working step. This meets the definition of divergent and convergent steps, while the functions described as divergent ones will always expand the set of aspects or extend the detailed description of an aspect. The functions that have been described as convergent working steps, will always imply a kind of analysis and cognitive load. Additionally, they are used for the purpose of clustering the set of input as well as reducing or extending the descriptions of influences by values inside the concept. The decision if the working procedure is following the approach was driven by the ordering and weighting of the working steps.

The underpinned quantitative analysis is based on a questionnaire that is designed as a set of items which could be assessed by a five-points-likert scale. Additionally, a closing free-text field for extra comments on the system and an input field for the users name is prepared. The latter is used to associate the questionnaire with the user's actions for the purpose of estimating its validity. The combination of both methods has been chosen with regards to the other objectives of the study. Some of them can be examined only by the qualitative approach, others only with the quantitative one. Table 1 lists the items of the questionnaire those have been used for the quantitative analysis of the described hypothesis. It has to be noted that these items determine the subjective impression of the participants. This will support the qualitative analysis of their working steps with regards to the difference between the noticed interaction with the system and the real done interaction. This way it becomes possible to identify the influence of the system itself to the chosen working procedure. After using the system, the participants were requested to fill out the given questionnaires.

6.2 Study Setting

The task of the participants was to develop ideas for an action that is common for Viva con Agua. In the end, they have to transform the ideas into influences described inside a concept.

As mentioned in section 4 and 5, the implemented type of concept is already known by the members of the social system. Nevertheless, the participants already had some experiences in working with this kind of concept, because in the context of this study they would not have enough time to learn the basic principles. Research focusing the work of inexperienced people can be part of the future perspective. So, eleven people which have or had roles inside the social system by which they often mingle with the used kind of concept, agreed to become participant for the study. Groups were formed under the condition that every group contains people which know each other and people which are unknown for the rest of the group. This should ensure real communication without a communication only based on implicit context information. Additionally, the groups should have the same size, so two groups of four members and one group with three members have been established. Such grouping supports the comparability of the results to reduce the influence of external factors as a cause for identified problems or findings.

The eleven participants had to work with the system during two weeks. As usual for the organisation they did it in their free time and got less instructions about the usage of the system and the working procedures. Preventing a time consuming process of initial ideation and decision-making inside the given group constellations, an initial frame was given. The participants had to create a concept for an event concerning the "World-Water-Day". This day is widely known inside the social system and a huge set of events were scheduled at this day during the last years. Therefor, it can be assumed that the participants had not to inform themselves about this day and mostly they will have a real interest in creating a concept for an event at this day. Additionally, the ideas of the last year can be used as a base by the participants.

6.3 Results

First of all, it was possible to identify both phases of divergent and convergent activities in the correct order, by a qualitative analysis of the logged user actions. The actions classified in 6.1 mostly followed the ordering described in section 3.3. So the users initially worked in a divergent phase of intensive discussion, naturally a group activity. During the divergent phase the users have always assigned an explicitly described aspect to each discussion input. This means they have done a divergent working step (creation of input) followed by a convergent one (assignment). Mostly, the assignment of an aspect was not done during only one step. The users often added or edited aspects, assigned one and removed the assignment. So the alternating switch of divergent and convergent working steps is observable. For example, one participant added a discussion input to suggest alternative possibilities for the realization of a "Flash mob". This divergent working step was followed by a convergent one, assigning the existing aspect "Flash mob" to the new input. Although the system allows to do this in one step. Mostly, the users changed their assignment between a new discussion input and existing aspects after they had saved their initial thoughts. So they performed a fast convergent action after they had seen the resulting discussion

thread presented by the system. That means the distribution between divergent and convergent steps followed the approach of Liu et al. [14] and is influenced by the systems presentation of the input.

However, the convergent phase can not be characterized as a group activity. This second phase was also entered by some participants, but it was never more than one group member. So the convergent phase was not entered by the whole group. It turns out that the support of collaboration by the system has to be extended. Most of the groups run into trouble while they try to reach a group consensus about the current working phase, because making such a coordination decision is not supported. Also the decision was made using the discussion thread, as exemplified by a participant (translated from German): "So, we've collected some ideas. Should we start to play around with 1-2 concrete suggestions?" Furthermore, it was possible to observe that the changes the users made during the convergent working phase were not noticed by the other group members.

Finally, the divergent phase follows the approach of Liu et al. and this is influenced by the system's design. Additionally, all groups tried to enter the convergent phase as a group activity. Their decision-making processes for this purpose were all initiated after reaching an acceptable set of ideas during the divergent phase. Also users initiating a convergent working phase did it always following a divergent one. So the ordering of the phases follows the approach. The analysis showed that the convergent phase did often not contain a divergent step. This is an issue that could be addressed in future development. Considering that the results of the divergent phase are by definition necessary for entering the convergent phase, the ordering of the phases is more influenced by the method itself than the new tool.

Next to the qualitative analysis of the users' working steps, the results are underpinned by the quantitative evaluation of the questionnaire. The evaluation of the first item shows that the users rarely planned their actions using the system. Following this, the motivation of the users to work by the approach of Liu et al. can be taken as a success of the system's presentation of functions. Additionally, the results of the items two and four implied that the users tried to orientate their own actions towards the group consensus. So the system has to motivate the whole group working by the approach. The behavior of one participant exemplified that the system supports the motivation of the whole group. She opened a discussion with one input and multiple aspects. Following this she added several influence descriptions to the concept. Afterwards, when the other group members restricted their interaction to detailed discussion, the participant also limited herself to the discussion and the creation of aspects. The proceeding itself was not discussed during this process of decision making inside the group. So the awareness about the others' behavior inside the system motivated the user to align her behavior to that of the group.

The items three, five and six are focusing the concrete sequence of working steps. The evaluation of item three is inconsistent with the observed behavior. The concepts are mainly not described, but the participants mentioned that they recorded every idea inside the concept. The item seems to be unclear. Following

item five, some participants noticed that they have discussed an aspect before they thought about potential influences, others did it the other around. This finding underpins the result that the construction of a group consensus has to be supported. At least the participants agree with each other that they try to discuss at first, followed by a description of the aspect's influences inside the concept.

As shown above, the results of the qualitative analysis of working steps are underpinned by the qualitative evaluation of the questionnaire.

7 Discussion and Future Opportunities

The presented work shows the development of a collaborative tool supporting creative concept generation. In section 2 the collaborating social system is described and its impact to the tools design is sketched. This is followed by an overview of related work, the requirement and the implementation of the tool. Afterwards, a study evaluating the tools design shows that the approach on creative processing of Liu et al. [14] will be supported. Additionally, it is shown that the system helps the user in selecting the correct working steps without forcing them into a specially designed working procedure.

The most problematic part of the evaluation is the notice that the convergent working phase of the creative process was not entered as a group activity. As a reason has been identified the missing possibility to define the group phase by the collaborating people. So, the implementation of coordinating functions will be a crucial step to bring the system in production. Especially, an explicitly support of the decision making process has to be created. Additionally, the implementation of an awareness system was only rudimentary given, because of the different focus of this work. So, making users aware of the changes inside the concept would help to communicate the process phase a user has entered. Furthermore, the transfer of discussion content into explicit influences inside the concept has to be analyzed. Currently, a detailed concept results in much scrolling, because the lists of influence labels are very long. Functions have to be designed that overcomes this limitation and helps the user to see changes very fast.

At least an interesting proposal by a study participant has to be mentioned. It was observed that a kind of a history function will help to note every change that was done in the users absence. This way, it will be possible to detect working steps of the convergent phase done by other users and to respond to it. Such a way, the users can define the currently entered group activity without explicitly decision making. Instead they can use the principle of a critical mass of users entering a phase of the working process to define the current group activity.

Next to the implications given by the discussion of the results above, there are some more possible future developments. It will be interesting to try the system for the purpose of organisational knowledge. Next to well implemented search and categorisation features the implementation of a recommendation system can solve the task. Graph structures using aspects of concepts as nodes and discussion

content as arcs between nodes enable the recommendation of the consideration of aspects based on discussion of other concepts.

References

1. Appelt, W., Busbach, U., Koch, T.: Kollaborationsorientierte asynchrone Werkzeuge. In: CSCW-Kompendium, pp. 194–203. Springer, Berlin (2001)
2. Asimov, I.: How Do People Get New Ideas?, `https://www.technologyreview.com/s/531911/isaac-asimov-asks-how-do-people-get-new-ideas/`, (2014)
3. Becker, K., Bacelo, A. P. T.: The Evaluation of GRADD: a GDSS supporting asynchronous and distributed meetings. In: Proc. CRIWG 2000, pp. 19–26. IEEE (2000)
4. Bozzon, A., Comai, S., Fraternali, P., Carughi, G. T.: Conceptual modeling and code generation for rich internet applications. In: Proc. ICWE 2006, pp. 353–360. ACM Press, New York (2006)
5. Chen, M.-H., Zhang, J., Lee, J.: Making collective progress visible for sustained knowledge building. In: Proc. CSCL2013. vol. 1, pp. 81–88. ISLS, Madison (2013)
6. Csikszentmihalyi, M.: Creativity: Flow and the psychology of discovery and invention. HarperPerennial, New York (1997)
7. Gamma, E., Helm, R., Johnson, R., Vlissides, J.: Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley, Westford (2010)
8. Herrmann, T., Kunau, G., Loser, K.-U., Menold, N.: Sociotechnical Walkthrough: Designing Technology along Work Processes. In: Proc. PDC 2004, vol. 2, pp. 132–141. ACM Press, New York (2004)
9. Herrmann, T.: Support of collaborative creativity for Co-located Meetings. In: From CSCW to Web 2.0: European Developments in Collaborative Design, pp. 65–95. Springer London, London (2010)
10. Holmer, T., Haake, J., Streitz., N.: Kollaborationsorientierte synchrone Werkzeuge. In: CSCW-Kompendium, pp. 180–193. Springer, Berlin Heidelberg (2001)
11. Kunau, G.: Facilitating computer supported cooperative work with socio-technical self-descriptions. Universität Dortmund (2006)
12. Kunz, W., Rittel, H. WJ.: Issues as elements of information systems. Working Paper 131. Inst. Urban and Regional Devt., Univ. Calif. at Berkeley. (1970)
13. Link, G.J.P., Siemon, D., de Vreede, G.-J., Robra-Bissantz, S.: Evaluating Anchored Discussion to Foster Creativity in Online Collaboration. In: Proc. CRIWG 2015. vol. 9334, pp. 28–44. Springer, Heidelberg New York (2015)
14. Liu, Y.-C., Chakrabarti, A., Bligh, T.: Towards an 'ideal' approach for concept generation. In: Design Studies. vol. 24, 4, pp. 341–355 (2003)
15. Nijstad, B. A., Stroebe, W.: How the group affects the mind: A cognitive model of idea generation in groups. In: Personality and social psychology review 10.3, pp. 186-213. (2006)
16. Sell, J.: Konstruktion eines technischen Systems zur kollaborativen Gruppenkreativität im Kontext der Konzepterzeugung. Diploma thesis, Humboldt Universität zu Berlin (2016)
17. Sternberg, R.J.: Handbook of Creativity. Cambridge University Press (1999)
18. Verheij, B.: ArguMeda template-based argument mediation system for lawyers. In: Proc. JURIX 1998, pp. 113–130. (1998)
19. Yuizono, T., Munemori, J., Kayano, A., Yoshino, T., Shigenobu, T.: A Proposal of Knowledge Creative Groupware for Seamless Knowledge. In: Proc. 8th International Conference KES 2004, Part II, pp. 876–882. Springer, Berlin Heidelberg (2004)