

## Collaborative Requirements Elicitation in Facilitated Collaboration: Report from a Case Study

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### Abstract

*User requirements elicitation is a complex process that requires stakeholders in teams to collaborate, go through decision-making processes and, finally, to arrive at consensus. During the user requirements elicitation processes, stakeholders who have different backgrounds, view points and understandings, need to clarify, capture and uncover user requirements in an efficient and effective manner. Many industry experts have admitted that collaboration among stakeholders in a facilitated workshop, aimed at defining and articulating user requirements, is one of the most difficult tasks in software development. In this research we present a collaborative process for user requirements elicitation. We used the principles of the Collaboration Engineering (CE) to design the process, which consists of ThinkLets, as process building blocks. We designed the process to predictably guide the stakeholders through decision-making processes in a collaborative manner. The process is evaluated in a case-study within an industrial IT firm in China.*

### 1. Introduction

Requirements engineering is a complex technical, social and cognitive process, which produces requirements for a software-intensive system [1]. Requirements elicitation is an important activity in the requirements engineering process as it involves discovering and formalizing the system requirements. During the elicitation process requirements are acquired from different sources and stakeholders.

Requirements engineering, especially during the stage of requirements elicitation, is a highly collaborative process. Understanding requirements of a system needs input from the stakeholders such as the

designer (IT) and the decision maker (Business). The designer, the decision maker, and all other stakeholders' experience, knowledge, expectations and perceptions cause dynamic influence on all aspects of system design and development processes and need to be addressed appropriately. Each stakeholder has different needs, expectations along with their own experience, prejudices and view points [4] that need to be satisfied by the introduction and delivery of the future system. Despite having alternative viewpoints about requirements, collaborating stakeholders aim to reach consensus and agree on the final list of system requirements [5].

Collaborative requirements elicitation has been studied by many researchers. In addition to a number of facilitated group approaches for requirements elicitation such as Joint Application Design (JAD) [6], Quality Function Deployment (QFD) [7] and Cooperative Requirements Capture (CRC) [8], several techniques and frameworks have been proposed that seek to address the challenges of collaborative requirements elicitation. Donzeli [9] presents a framework that provides an environment within which the stakeholders and the analysts can cooperate to discover, organize, reconcile and validate the requirements of a new system. Mich et al. [10] describe the problem with collaborating stakeholders who need to identify and enhance their viewpoints and are involved with requirements elicitation processes. They propose a creative technique based on a model of the pragmatics of communication. The model defines a creative process that consists of different steps. In each step the problem is analyzed based on an elementary behaviour identified by the model. Finally, Haruhiko et al. [11] discuss the problem of requirements discordances among stakeholders and suggest a collaborative goal-oriented requirements elicitation

method to address it. Although some of these approaches describe a detailed procedure for discovering and eliciting requirements they offer limited support on the issue of how to facilitate requirements elicitation workshops without an expert facilitator while the collaborating stakeholders reach consensus over system user requirements.

This study aims to contribute to the literature on collaborative requirements engineering by eliciting and discussing the results of using a ThinkLets based process for supporting this important and much studied activity. In considering the application of ThinkLets to this important business domain, the literature on collaboration technologies is also extended. Some of the findings from this study provide additional support for knowledge about the use of ThinkLets in group settings, additional findings are observed adding to the collected literature. The approach introduced in this paper is evaluated in an industrial case-study within an IT firm in China. We used semi-structure interview to collect data from the participants in the workshop. By carrying out the interviews, we aimed to better understand the process predictability, efficiency and ease of use when applied to user requirements elicitation workshops.

## 2. Background

User requirements have always been difficult to clarify, capture and articulate. Many industry experts have admitted that defining them is the most difficult task in software development. For example, one of the biggest problems is the gap in communication between software experts and business people, which results in a low level of consensus building. This problem also exists for both external software development organizations and software groups supporting internal organizations [12]. In this paper the authors focus on facilitated collaborative user requirements elicitation workshops. The authors use Collaboration Engineering (CE) to deliver a process that satisfies the recurring need of discovering and capturing the user requirements in organizations.

### 2.1. Requirements workshops

Requirements workshop is a generic term given to a number of different types of group meetings where the emphasis is on developing and discovering requirements for a software system [13]. A requirements workshop is a structured meeting in which a selected group of stakeholders collaborate to define the workshop deliverables that represent user requirements. It is usually a facilitated group meeting. The workshop deliverables can be in the form of requirements models such as diagrams, lists or tables

that are used to document users' needs [12]. A requirements elicitation workshop generally includes participants who are not too familiar with each other; the more diverse the views that are represented, the more reliable or robust the results become. It is very difficult for users to anticipate fully their future system requirements. They can generally express what they want in the present time, and requirements elicitation techniques should guide them to discover needs based on future usage scenarios [14].

### 2.2. Collaboration Engineering

Collaboration Engineering is a rapidly evolving design approach that is used for modeling and deploying repeatable, predictable and transferable collaboration processes for recurring high-value collaborative tasks to be executed by the practitioners themselves [15][16]. Vreede and Briggs [17] define the scope and key elements of Collaboration Engineering as follows: The collaboration engineer is able to create designs in the form of a standard, repeatable procedure that can be followed to ensure a predictable success within a team development effort. Collaboration Engineering offers guidelines to decrease the challenges of facilitation interventions within a team [18]. It is important for organizations not to be dependent on skilled facilitators, who may either need to be trained inside the organization or be hired as expensive external consultants. Instead, organizations need to leverage effective collaborative processes, and train "practitioners" to run them [19]. A practitioner is a domain expert who executes a particular work practice designed by a collaboration engineer. Practitioners do not need to have the skills to design or conduct collaborative processes; they execute tasks that are transferred to them [19][20]. The practitioners are in essence, novice facilitators, individuals that possess the potential to act as facilitators by learning the techniques transferred to them using the processes developed by a collaboration engineer [21].

### 2.3. Facilitated Collaboration using ThinkLets

To design a predictable, transferable, reusable collaboration process, the Collaboration Engineering approach uses design patterns called ThinkLets, which can be combined to create a sequence of steps for a group to execute in order to achieve collaborative goals [22]. ThinkLets are facilitation building blocks that describe how a task should be performed using pre-defined scripts [23]. These scripts are comprised of a set of atomic collaborative activities. Any individual ThinkLet comprises a named, packaged, thinking activity that is able to create predictable, repeatable patterns of collaboration, the approaches

that groups use during collaboration [17]. ThinkLets are codified scripts of key facilitation intervention techniques, used by the collaboration engineer to design standardized and routine collaborative processes that are easily transferred to practitioners. The ThinkLets enable practitioners to become independent, through learning the configurations for execution of the processes. Consequently, practitioners only need to know the skills that are specific to the process they have in hand, which are well described and embedded inside thinkLet scripts [24]. ThinkLets are classified according to the patterns of collaboration they create. Briggs et al. [20] identified the following six basic patterns of collaboration (1)Generate: Move from having fewer concepts to having more concepts, e.g. the directed FreeBrainstorm ThinkLet that generates a broad and diverse set of highly creative ideas in response to prompts from a moderator and the ideas contributed by team mates [25]. (2)Clarify: Move from less to more shared meanings of the concept(s) under consideration, e.g. the FastFocus ThinkLet that generates ideas in depth on a focused set of topics [25]. (3)Reduce: Move from having many concepts to a focus on fewer concepts deemed worthy of further attention, e.g. the FastHarvest ThinkLet that extracts a list of key ideas from a raw set of brainstorming comments and assures that team members agree on the meaning and phrasing of the items on the resulting list [25]. (4)Organize: Move from less to more understanding of the relationship among concepts, e.g. the PopcornSort ThinkLet that is used to quickly organize a large set of ideas into categories [25]. (5)Evaluate: Increase understanding of the utility or priority of the concepts in relation to goal attainment, e.g. the StrawPoll ThinkLet that is used to evaluate a number of concepts with respect to one or more criteria [25]. (6)Build-consensus: Move from having more disagreement to having less disagreement on courses of action, e.g. the CrowBar ThinkLet that is used to discover and discuss the reasons behind disagreement on certain issues [25].

Since they have mnemonics they are easy to memorize and use as a shared language in communities of practice. Therefore, ThinkLets offer a basis for training practitioners to become skilled and independent in their ability to support the collaborative work practice [22].

### **3. A Collaborative Requirements Elicitation Approach**

Stakeholder collaboration is a necessity rather than a matter of choice in user requirements elicitation. In this research we used the principles of

Collaboration engineering (CE) [30] to identify patterns, select ThinkLets and finally design the collaborative process for requirements elicitation.

The process consists of six different tasks:

(1) Task-1: Identify relevant user requirements. The result of this step is a list of user requirements.

(2) Task -2: Analyze features for each group of users and categorize user requirements into groups of users. In this step features are identified and assigned to the different groups of users. Three groups of users have been proposed by Human Factors Experts at the HUSAT research center at Loughborough University, UK [8]: Primary Users: the most frequent hands-on users of the proposed system. Secondary Users: occasional users or those who use the system through an intermediary. Tertiary Users: those who are unlikely to be hands-on users but will be affected by the introduction of the system or will be influenced by its purchase. The user requirements are categorized according to the type of user

(3) Task -3: Identify user requirements within each category. The result of this step is the lists of user requirements within the specific categories.

(4) Task-4: Discuss to ensure correct categorization. The delivery of this step is an overview of the categorized users.

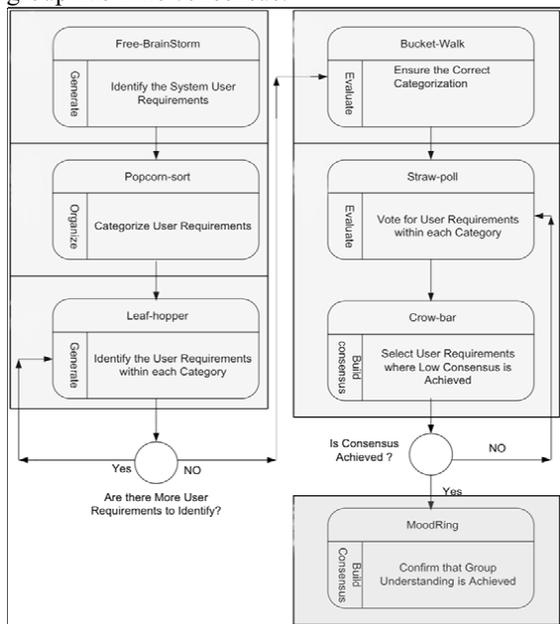
(5) Task -5: Vote for user requirements within each category based on priority and discussion to reach an agreement on those user requirements where a low level of consensus is achieved: The result of this step is users with all features prioritized according to business value and feasibility.

(6) Task-6: Confirm that overall group understanding about the categorized and prioritized user requirements lists is achieved: The result of this step is an agreed list of evaluated and categorized user requirements.

The six tasks are performed in an iterative manner to allow frequent feedback. For instance, it is common in task 3 that new domains are identified during the discussion of the requirements which will require the collaborative collection of features for these new domains (task 2). It may also happen in task 5 that as a result of the prioritization a domain is considered obsolete and has to be deleted from the final list of requirements.

Figure 1 shows the suggested for this case study thinkLets and the collaboration pattern associated with them. The process uses seven unique thinkLets for the six tasks. Nevertheless, the facilitator retains discretion in the actual implementation of the particular meeting. ThinkLets can be dropped or used in a different sequence when conducting the approach in a particular instance.

The tasks supported by ThinkLets are illustrated below using a requirement elicitation workshop. The workshop starts by participants generating user requirements (Task-1). Free-BrainStorm is the ThinkLet chosen for Task -1, with participants' quickly stating divergent ideas in response to the prompting questions. Next the participants categorize the requirements (Task-2), using the PopcornSortThinkLet. Normally after a divergence activity like FreeBrainstorm, PopcornSort is used to converge and organize the ideas into related clusters or categories. The LeafHopperThinkLet collects team members' ideas about each of the categories, by brainstorming within all the categories at once (Task -3). The BucketWalkThinkLet is used to validate the results of PopcornSort or LeafHopper; participants are encouraged to review the contents of each category to make sure they are correct (Task -4). If any participant questions the content of a category, the group starts a moderated discussion to make further decisions before going on to the next stage. The BucketWalkThinkLet is used to remove redundancy and consolidate the features for each domain. In Task -5, participants evaluate the requirements inside each category based on their priority, in a voting session. StrawPoll helps to measure consensus and to reveal the patterns of agreement or disagreement with the group. Using the chosen voting method (e.g. a 1-5 scale), participants decide which requirements are more important (have priority) than others. Also in Task -5, the CrowBarthinkLet is used to survey and examine assumptions and to share previously unshared information, focusing discussion on topics where the group has little consensus.



**Figure 1.** Collaborative process for user requirements elicitation

Participants are encouraged to repeat Task -5 until an acceptable level of consensus is achieved.

Finally, MoodRing is used to track patterns of consensus on a single issue in real time, and to indicate when it is time to stop talking and make a decision. MoodRing ensures agreement and consensus among participants about the overall outcome of the session (Task-6). Figure 1 illustrates the collaborative process for user requirements elicitation.

The script of each ThinkLet contains rules for a participant in a defined role for creating the required pattern of collaboration. These rules describe the actions a participant must execute, under a given set of constraints [26]. The scripts for all the ThinkLets are derived from papers [26][27][28] and can be found in Appendix A.

### 3.1. Case Study

In order to validate the designed collaboration process intended to help participants perform more effective collaboration for requirement elicitation, we applied the pattern in a real business case. Therefore, our case study questions are: Is the designed collaboration processes useful for the real business collaboration? and what enhances and inhibits the effectiveness of this designed collaboration process? Company A is a leading Chinese national software development company whose business is mainly in the telecommunication field. The company develops software for telecommunication management, mobile systems, information security, and enterprise management. It also provides consulting and technical support for business. It has built partnerships with many companies. In recent years, its business has expanded to many overseas markets such as US, Germany and the Middle East. Currently, it has more than 1500 employees worldwide. The company's headquarters is located in Beijing which is also where the company's software development team is located.

Access to this study site was derived by working with one of the company's software development teams currently engaged in a project related to mobile system development. As part of this research study, the team participated in a group conference discussing the requirements for part of their system development project. Their prior approach to requirements elicitation has been through face-to-face meetings supported by using PowerPoint capabilities. No formal guidelines had been imposed by the organization for conducting these sorts of meetings and, therefore, group members were free to evolve

their own norms and procedures. In the previous meetings, one participant normally recorded meeting minutes. The meeting observed in this research project was attended by six participants from the development team. The team was provided with a thinkLets based collaboration process to facilitate their meeting with support from GroupSystem (ThinkTank). In order to make the collaboration process meet the organization's needs, the research team communicated several times with the team leader who served as group facilitator before conducting the research project. The research team provided extensive instruction to the team leader to prepare for use of the collaboration process and system.

### 3.2. Data Collection

In the meeting, the research team did not participate but only observed the group's interaction. The team used the thinkLets based collaboration process to develop requirements for their mobile system project. The task aimed to elicit the current requirements in one part of their current mobile operation systems development project. They moved through the thinkLets session one module after another sequentially through the process of Brainstorming, Bucketwalk, Popcorn sort, Leafhopper, Bucketwalk, Strawpoll, Crowbar and Moodring. They used the thinktank which is embedded with the thinkLets. The session was conducted face-to-face with ThinkTank support. None of the team members had used the ThinkTank system or thinkLets previously. Each team member was equipped with a laptop and they were also able to speak with each other while using the collaboration system. There were no observed problems with the functioning of the technology during the session. Team members reported successfully prioritizing the requirements as a result of the meeting showing that their chosen task was successfully completed. They spent a total of approximately one hour for the session. However, due to the privacy of the data protection rules, agreed upon before the session, the specific content of the discussion cannot be disclosed in this paper. After the session, we interviewed five participants including the team leader, all of whom are software engineers. The team leader (Respondent C, Female) has three years experience in requirements engineering, and three other interviewees have one year's experience (Respondent A, D, E, Male), and the other has half a year's experience (Respondent B, Male). Individual audio-taped semi-structured interviews were conducted after the session. Each

interview lasted about half hour. The interview questions are presented in Appendix B.

## 4. Method

The approach taken in this study is a fairly standard cognitive mapping process [29].

Data is collected through a series of interviews following participation in the group activity. This activity and interviews were conducted in Mandarin Chinese then we translated into English for further analysis. Comments of a similar nature were grouped together (see tables 1-6 below) with the common themes of these comments leading to a set of observations formulated as statements. The comments are presented in the tables with the statements accompanying. These statements are then presented in graphical form. When all statements have been produced in graphical form, they are aggregated and reformatted into a single graphical representation that shows all of the interconnections among precursor and effect variables. For each result, (see Tables 1-6), we generated one figure, then we integrated all the figures into a single graphic representation presented as Figure 2 below.

## 5. Results

Our results are presented as a series of observations where each observation represents a linkage of meaningful statements generally voiced by more than one of the five interviewees. These comments are based on their reactions to the collaborative activity.

### 5.1. Standardizing the process makes it easier for team members to categorize questions and perform analysis.

A standardized collaboration process is helpful for participants to generate and consider the ideas, and finally this will contribute to the consensus building. The evidence from the interviewees is listed in Table 1.

**Table 1.** Interviewee comments for results 5.1

| Respondent | Comment  |
|------------|--|
| A          | Yeah, it is helpful, this is very good. I think this way is a more specific embodiment of everything completely implemented. In such a way, because everyone involved doing the record, this will generate more completed records. |
| A          | This process is much better. We wrote down these ideas we had came out. In the future, we can check these items after the meeting to avoid forgetting. It makes the outcome of   |

|   |  |
|---|--|
|   | the meeting much clearer and put all the ideas together.   |
| A | I think this process is more specific, and it makes all things to put into effect. Because everyone has to take part in this and to record ideas, which is much better than one person doing these.              |
| B | I think it is helpful to use this process, the steps are more standardized, so the problem can be unified trace and a unified discussion is quite efficient in the limited time to discuss more issues.          |
| B | In these processes, all the steps are more standardized. We can put all the questions together firstly. The final discussion is effective, because we can discuss more questions in limited time.                |
| C | I think it provides a very detailed record and make archived results.  |
| D | Definitely yes, this software specific, standardized, that is, step by step plan, and then generate a Word document, that is what you discussed can be persistent, so it is certainly helpful to the whole team. |
| E | This process can record from a problem to its answer fully and the process will also be recorded in great detail. This is a very good help to our group meeting.   |

**5.2.Using the “Bucketwalk” and “Strawpoll” modules of the thinklets in the collaboration process is helpful for building consensus.**

These two modules are from thinkLets and each proved helpful for the participants in building consensus. Some comments from the interviewees are listed in the Table 2.

**Table 2.** Interviewee comments for results 5.2

| Respondent | Comment   |
|------------|---|
| A          | After voting, it can analyze trends and the degree of dispersion, so that the statistics can tell us whether a consensus has been reached |
| B          | The vote can reach an agreement, any drag (bucketwalk) is also a consensus process; they can help reach a consensus at a certain extent.  |

**5.3. The design of the process involves the participants to a larger extent which achieves more complete answers and a higher level of**

**consensus and leads to better decisions and more productivity and decision quality.**

This observation represents a composite of interlocking comments by four of the five participants. The process is seen to be involving more participants and enhancing participation in the collaboration. It does this by leading to more complete answers, thus increasing productivity. Additionally better participation from the participants leads to consensus building and heightening decision quality. The comments from the interviewees are listed in Table 3.

**Table 3.** Interviewee comment for results 5.3

| Respondent | Comment   |
|------------|---|
| A          | We put different ideas from different persons together.   |
| A          | There’s an advantage of the process that it attracts more group members to take part in the voting even all the members. So we achieved a more completed answer.                                |
| B          | It made me known what should I do in every step in our project. And it helped me to make decision. We recorded ideas when we discussed by the standard, so we found the key points more easily. |
| B          | It can help you to categorize questions and give you a final report. I think the report is very useful.   |
| D          | The former methods only give us some suggestion. But now we can improve productivity by the more participation.   |
| D          | Because each process involves all the members, the result can reflect the common ideas and easily lead to a consensus. It is better than previous methods because of more participation.        |
| D          | This process is more standardized and more specific by showing the outcome in a more intuitive form. It is standardized, specific, intuitive and efficient.                                     |
| E          | It feels very good. It can make our discussion more systematic and comprehensive. Everyone can make their comments, which can help me to draw some new ideas.                                   |

**5.4. The archived records produced in the standardized collaboration process help team members to review and work with the documents in the future.**

The standardized process lets participants record ideas which helps them review ideas and position them to access and re-examine them in anticipated future use. Examples of comments from the interviewees are listed in Table 4.

**Table 4.** Interviewee comment for results 5.4

| Respondent | Comment  |
|------------|--|
| A          | The advantage of this process is recording those ideas during the meeting, and generated a report, then we can discuss clearly in the future.  |
| B          | Help is definitely there, from the report results, let me know which issue should be resolved before and this point is still helpful. During the discussion, it can help me correct the direction of the future. |
| E          | The statistics can tell us which is more agreeable and which is very important, I think this result is helpful to improve our work in the future.  |

### 5.5. Completeness of system use regarding the criteria and their weighting voting, improve voting results and their quality.

When the participants use the system more completely, such as by creating multiple criteria voting, and consider the weights of voting, there is an observation of better quality of results. The comments examples from the interviewees are listed in Table 5.

**Table 5.** Interviewee comments for results 5.5.

| Respondent | Comment  |
|------------|--|
| D          | I think the form of expression of today's results is simple, as well as we just consider one criteria of voting. I think we should consider the multiple criteria voting.  |
| E          | In fact, everyone's voting weight is not the same in one question, because someone does the main task and someone else just know a little in one project, but today they have the same weight, this will cause some error. |

### 5.6. The process is easy to use and to understand therefore it is likely to be used.

Since participants feel it is easy to use, they are more likely to use the collaboration system. Comments are listed in Table 6.

**Table 6.** Interviewee comments for result 5.6.

| Respondent | Comment   |
|------------|---|
| A          | This process very easy to use, may be accustomed to will be much quicker. Today this process is quite clear |
| B          | Today just do once, but I think I will familiar with it after several times.                                |
| C          | Very easy, no problem, it is the  |

|   |   |
|---|---|
|   | normal process. Do not need to spend time to learn it.  |
| D | It is very easy, very easy to get started and simple to understand. As long as this are familiar with the following will be used, it is easy to understand. |
| E | I think in the whole of this process, the better used from start to end. Oh, no. this is very easy and very simple.   |

## 6. Discussion

Our analysis has led to six elemental observations. In each observation we see that respondents view a number of precursors leading to particular kinds of outcomes. In Figure 2, we integrate these elemental observations showing how some precursors are viewed in different contexts to have multiple effects. In this figure, each “bubble” represents a concept emergent from the interviews and each “arrowed line” shows an observed linkage, potentially causal but possibly correlational, between one concept and another. This representation should be interpreted as tentative showing the observed relationships but requiring further investigation to determine more fully the nature of those relationships. Most notable, we found standardized processes to influence idea recording and analysis quality and idea recording to influence analysis quality directly as well as future use.

We have placed the several “dependent variables” or results at the center of the integrated graphic. We are suggesting that each of the effects may mutually influence the others. It stands to reason that the amount and quality of use will affect all other outcomes. Similarly, it is difficult to envision quality of decisions without quality of analysis and vice versa, it is difficult to imagine that better structuring and processing of decision activities will not lead to better analysis.

Additionally, by analyzing the data from the interviews, we find five suggestions for possible improvements to the collaboration process.

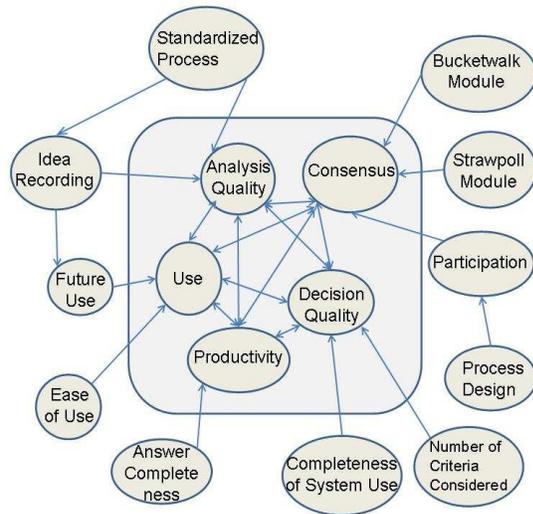
First, we find that voice input should be considered in future system design. Using voice rather than hand typing may aid the efficiency of data input. As technologies that transcribe oral communication into written language improve, consideration may be given to integrating these capabilities into the group support technologies. Participants specifically stated: “... typing in the face to face situation ... is more trouble than speaking each other”, “I think the recording is more effective, that [it] is more timely”, “we are discussing things

together, voice communication may be a richer source of information. So with the input of this text there is some inhibition”

Second, we find that using a professional assistant for recording ideas could be considered.

If there is some one recording content for the participants rather than everyone typing, this might lead to efficiency gains. Some interviewees mentioned that “if we find a person to do the records in the meeting, I think it will be better”, “I think if there is a special person to record will be better, and I think can increase the variety of input methods, it can speed up the transfer of this information then will be better”

Third, we observe that training for the participants to get them familiar to the process and system use will prepare them to use the system in a more standardized way, enter data into the system in a more well timed and targeted way, and, in turn, result in better meeting outcomes.



**Figure 2.** Integrated mapping of the collaboration elements

Comments upporting this recommendation include: “In the discussion, without someone to record the session, we forgot to enter some content and, thus, the final result is not complete. If we can use this process in a more standardized way, the quality of the final results will be more accurate.”, “if This process can focus on better input, it will provide more satisfaction with the meeting.”

Fourth, there is a need to allow the participants to distribute the weights of voting. In the (strawpoll) voting, we may consider the voting participants’ preferences in distributing the weighting of criteria to avoid possible mistakes. One participant expressed this by saying, “In fact, everyone’s voting weight is not the same in one question, because someone do the main task and someone just know a little in one

project, but today they have the same weight, this will cause some error.” And fifth, it would be helpful to incorporate multi criteria voting.

In the (strawpoll) voting, considering multiple criteria for voting would lead to better and more precise results. This was stated by a participant as:

“I think the form of expression of today’s results is simple, as well as we just consider one criteria of voting. I think we should consider the multiple criteria of voting.”

The use of the thinkLets in the context of the entire collaborative support environment was generally regarded as helpful. In spite of identifying several channels for improvement, overall the specific design for the meeting task and availability of system functionality can serve as a useful base for future rounds of requirements design.

## 7. Conclusion and future research

The task of requirements elicitation is clearly a basis for effective design and creation of new technologies when well done, and a major problem when done poorly. We view this case study as an early step toward identifying opportunities for collaboration process design to provide advantages to those performing this important task.

As with all research, this study must recognize its limitations. There are always a great many moving parts when applying technology in real life situations. In this case we had a significant level of enthusiasm and buy in among the participants. We cannot be sure that other cases where there is more conflict, more diverse goals, or a larger and more complex overall project, we would observe the same results. Naturally, we view this particular case as one of what will (hopefully eventually) be very many so that findings consistent across situations and those specific to particular applications will become clear. Additionally, our data were gathered through interviews. This provides the opportunity to penetrate more deeply into the nature of the issues but may yield some variance in the consistency of specific wording of questions as well as the effects of interviewer learning as part of progressing from one to the next interview. The study was also conducted in China so aspects of evaluation of the meeting and systems may be influenced by particularities of the culture and business climate which may give the case study unique characteristics. Meetings were conducted in Chinese and analysis conducted initially in the original Chinese and subsequently from comments translated into English. Some potential for differing interpretations of the details of meaning across language and culture groups may persist, even though efforts were made to make sure that original

meanings of the interviewees were clear to all researchers on this project.

In the future, we expect to conduct additional case studies to be able to contrast and aggregate findings across a wider range of instances. We anticipate conducting additional evaluation in other commercial settings or within a larger-scale project to explore the possible variations of the collaborative process and testing it with alternative ThinkLets. We would also consider replicating a similar setting with comparable groups of participants/stakeholders. We anticipate a future research program that incorporates examination of the use and results of particular thinkLet activities and their sequencing particularly looking for examples of where small changes in activity and sequence produce disproportional changes in results. We envision adding additional perspectives for the social effects of use of this approach on issues such as long term relationship building among team members and development of norms and procedures which smooth activities and movement between them. We hope to reexamine projects at completion to identify the role of information requirements benefits experienced in efficient meetings and quantify their effect on overall project performance. We intend to conduct more experiments and build an ongoing relationship with "Company A" to measure effects of the intervention within the larger context of organizational change.

In this paper, we conducted a case study of a IT firm to test our proposed collaboration process design from the requirement elicitation approach. We tested the process, analyzed the outcome and also provided several suggested improvements that ought to be considered more generally as possible system enhancements.

## 8. Acknowledgement

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participants to add one contribution that matches the contribution specification to each page they receive, one at a time, in parallel. Ensure that participants randomly swap pages after each contribution. Ensure that participants read the contributions of others for inspiration. (2) *Popcorn Sort*-Role: Participants; Capability: Categories, ideas that can be moved (categorizer tool, flip-over and post-it or pin wand); Rules: Allow participants to move ideas into the category they belong to. Ensure that participants do not move ideas that are already categorized. (3) *Leaf Hopper*-Role: Participants; Capability: A page for each category visible to all participants, to which all participants can add ideas to all pages (categorizer, flip-over sheets); Rules: Allow participants to add any number of contributions to any category in parallel. Allow participants to add only contributions that are relevant to the categories in which they are placed. Allow participants to add only contributions that match the contribution specification. Let participants shift focus from category to category as interest and inspiration dictate. Ensure that participants read the contributions of others for inspiration. (4) *Bucket Walk*-- Role: Participants, Facilitator ; Capabilities: Participants: view clustering, suggest changes; Facilitator: check agreement. Rules: Let participants identify unclear contributions in brainstorming results. Ask the group to clarify the unclear contribution. Edit the contribution to reflect the result. Let participants identify contributions that do not reflect the category in which they are placed. Ask the group to suggest alternative classification. Re-classify the contribution to reflect the result. Let participants identify overlapping contributions. Merge overlapping contributions with consent of the group. (5) *Straw Poll*-Role: Participants; Capability: A list of ballot items with the ability to rate each on a specified criterion (voting tool or ballot papers); Rules: Allow participants to rate each item on the scale privately. Calculate the resulting mean and standard deviation. Display the voting result on the central screen and/or participants' screens and present top, bottom and standard deviation. (6) *Crow Bar* Role: Participants; Capability: Preferably face-to-face discussion, overview of standard deviation of vote. Rules: Focus on the items with high disagreement. Ask a group member to formulate an argument to rate the idea high on the criterion, despite his own vote. Ask a group member to formulate an argument to rate the idea low on the criterion, despite his own vote. Participants are allowed to reveal their vote, but are not forced to. Determine the source of disagreement with disconsensus diagnostics. Resolve disagreement or park the issue. (7) *Mood Ring*-Role: Participants; Capability: A reusable scaled discriminator for the issue. Rules: Indicate your opinion on issue (X) on criterion (Y) using the scaled discriminator (Z). Discuss the issue. Indicate any change in opinion. Continue until there is sufficient consensus.

## Appendix B. The Interview Questions

Please note that all interviews were conducted in Mandarin Chinese and the questions below represent a version of them translated into English. The interview begins with general questions about the background of each participant, where they serve in their company, the nature of their job, their level of work experience and their experience in requirements elicitation. (1) What is the predictability of the process design? (2) How about the supportiveness of the process design in application to the "real life" case they use to collaborate and supportiveness of the process in comparison to previous methods they have used before? (3) What do you think about the ease of use of execution? (4) Could you talk about the cognitive load of execution? (5) How is the productivity of the process in comparison to other similar techniques they used before? (6) How do you like the quality of the list of produced requirements during the workshop? (7) Did the process help you to do decision making more efficiently compared to other methods? (8) Did the process help you to make consensus and reach agreement over the system requirements? Can you compare it to other approaches you have used before?

## Appendix A. ThinkLet Scripts

ThinkLet scripts used in the collaborative process designed in this paper are as follows [26][27][28]. (1) *Free Brainstorm*-Role: Participants; Capabilities: Set of pages. Each participant can add ideas to the page assigned to him; after contributions, pages are randomly swapped among participants. ThinkTank does not yet automatically swap pages, but might create this in the future as it was part of the old system. Rules: Allow