Concept Development with Real Users: Involving Customers in Creative Problem Solving

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Abstract. This paper describes idea generation activities in a user-centered concept development project when creating a new Enterprise Resource Planning system. With detailed statistics of the produced ideas we show that different creative problem solving methods are feasible to allow real end-users to generate ideas to improve their own ERP system. Our results show consistent success in using the various methods and a remarkably high percentage of new ideas were selected for further evaluation by the developers of the system.

Keywords: User-Centred Design, Concept Development, Creative Problem Solving, Idea Generation.

1 Introduction

This paper describes idea generation activities within a concept development project initiated to create a concept for a next generation Enterprise Resource Planning (ERP) system. The goal was to find both immediate improvements for ongoing product development and a longer-term vision to guide the future development activities in the coming five to ten years.

The used iterative concept development process includes five phases, namely 1) Project commitment, 2) User and technology research, 3) Innovation sprint, 4) Concept creation and validation and 5) Project assessment [1]. Previously this process has successfully produced concepts ranging from mixed reality demonstrators for children [2] to natural language interaction for mobile maintenance men. In these earlier concept development projects the users have not been fully involved in the actual innovation sprint as sole providers for the generated ideas.

Problem and idea finding is a critical period during the innovation sprint. It generates and rates the new ideas and features to form the basis for the new product concept. Four customer companies currently using Lean System [3] were studied during the user research phase and were asked to participate in the idea generation within the innovation sprint phase. The motivation for inviting actual users into the idea generation sessions was to explore whether groups of non-designer users, with no prior experience with formal creative problem solving, can produce feasible ideas for concept development and how the chosen idea generation methods affect the efficiency of the sessions.

M. Kurosu (Ed.): Human Centered Design, HCII 2009, LNCS 5619, pp. 869–878, 2009.

1.1 Learning the Companies Processes and Practices

In the following we recount the data collection and analysis leading to the creative problem solving tasks that identified and formulated the working hypotheses for the idea generation sessions. Half day workshops with the participating four companies were attended by employees portraying the entire production process from sales and marketing, production design and management, subcontracting and acquisitions, actual factory floor personnel, logistics and after-sales and maintenance. Using dialogical methods (for example see [4]) the companies' processes and practices were studied to find out the bottlenecks and problems in their processes and within their current ERP solution.

The processed materials included mainly audio recordings of the workshops from which interesting observations, related directly to the ERP system or the process surrounding its use, were collected. These observations were grouped and analyzed as an affinity diagram. From this analysis emerged five common themes to be used as the working hypotheses or problem statements for idea generation. For later reference these themes were:

1) Securing all *communications* into the system,
2) Availability of *documents and tools* in the system,
3) Improving visibility and traceability of *changes,*
4) *Fragmentation* of information within the system and
5) *Trust* towards the system and (real time) accuracy of its data.

1.2 Participating Companies

The study investigated four companies currently using Lean System ERP.

Company A. Company A has 2000 employees. The production process including export, acquisitions, production scheduling, manufacturing and forwarding/logistics was reviewed in the workshop which focused on the action prerequisites for delivering products in the planned schedule.

Company B. Company B has 62 employees of which 36 work in manufacturing. The production process including sales, product design, purchasing, production scheduling, manufacturing, quality control and financial administration was reviewed in the workshop which focused on successful completion of export projects.

Company C. Company C has 110 employees. The production process including sales, product development, purchasing, production scheduling, manufacturing and quality assurance was reviewed in the workshop which focused on product development projects and how gained knowledge can be utilized in serial/mass production.

Company D. Company D has 270 employees working in Finland and roughly 30 employed by affiliates in other countries. The production process including product development, custom product design, purchasing, manufacturing including subcontracting, service parts, maintenance, and financial and IT administration was reviewed in the workshop which focused on change management in the order-delivery process.

2 Creative Problem Solving

The creative problem solving (CPS) process which includes six stages, namely 1) objective finding, 2) fact finding, 3) problem finding, 4) idea finding, 5) solution finding and 6) acceptance finding [5] can be seen to have stages comparable to the iterative concept development process used. Especially the problem and idea finding stages of CPS are inherent and appropriate for the innovation sprint in concept development.

Idea generation methods can be classified into two categories, intuitive and logical, based on the quality of the process for generating ideas. A further sub-classification of intuitive methods has also been made into germinal, transformational, progressive, organizational and hybrid methods. [6].

McFadzean [7] concludes that creativity can be enhanced in five different ways: freewheeling to produce as many ideas as possible, association with already produced ideas, suspending judgment, using unrelated stimuli and applying unusual modes of expression. The latter three aspects differ by CPS method while the first two are common to all CPS methods. Based on these aspects McFadzean has developed a framework for creative techniques, called the creativity continuum, where all CPS methods can be placed. On this continuum CPS methods can be further grouped to paradigm-preserving, paradigm-stretching and paradigm-breaking.

The methods in these groups imply different considerations for the facilitator and the group using the methods in idea generation. Although paradigm-stretching and paradigm-breaking methods produce more creative and different ideas by forcing the participants to look at the problem from different perspectives and to use uncommon ways of thinking, they are more demanding for the group using them. For inexperienced groups paradigm-preserving techniques are more suitable because of their familiarity and safety [7]. Also for paradigm-stretching and paradigm-breaking methods to be effective, the group must be able to trust the other participants and the facilitator [8]. De Bono [9] according to McFadzean [10] has stated that changing paradigm requires lateral thinking, which is lateral movement to try new concepts and perceptions in relation to the problem.

The chosen methods for our workshops were classical brainstorming, a variation of the Method 635 brainwriting and six thinking hats by De Bono. Brainstorming and brainwriting are both paradigm-preserving methods [7] while six thinking hats is paradigm-stretching.

2.1 Classical Brainstorming

Classical brainstorming was introduced by Alex Osborne [11] as a creativity technique for groups. The session comprises of more than just idea generation, from statement of the problem to presentation of the result. Classical brainstorming includes four basic rules [5]: 1) Criticism is not permitted — adverse judgment of ideas must be withheld; 2) Free-wheeling is welcome — the wilder the idea the better. One should not be afraid to say anything that comes into one's mind. This complete freedom stimulates more and better ideas; 3) Quantity is required — the greater the number of ideas, the more likelihood of winners; 4) Combinations and improvements should be tried out. In addition to contributing ideas of one's own, one should suggest

how ideas of others can be improved, or how two or more ideas can be joined into a still better idea.

Putman, [12] and [13] according to [14], provided the participants with additional instructions and reported a 40% increase in the number of ideas generated in brainstorming groups. The set of additional instructions was: 1) Do not tell stories or explain ideas; 2) When no one is saying ideas, restate the problem and encourage one another to generate more ideas; 3) Encourage those who are not talking to make a contribution; 4) Suggest that participants reconsider previous categories when they are not generating many more new ideas.

Including a 2-5 minute break in the middle of a 20 minute brainstorming session has been found to increase productivity after the break [15] according to [14]. Instructing the participants to think of the problem during the break and write down any additional ideas resulted in a higher increase in productivity than not giving such instructions.

2.2 Method 635

Brainwriting is a written form of brainstorming, where the same rules apply. Method 635 includes six group members writing down three ideas in a period of five minutes and then passing the papers to the adjacent person. The method was developed by Bernd Rohrbach in the 1960s [16]. Many studies have concluded that brainwriting in groups produces more ideas than brainstorming [17].

2.3 Six Thinking Hats

The method of six thinking hats by Edward de Bono [18] uses the idea of taking on different perspectives to the problem. The white hat is focused on information and data, the red hat is concerned with feelings and intuition, the black hat is about critical assessment, the yellow hat is optimistic and positive and the green hat is for creativity and growth. The blue hat is reserved for the facilitator to guide the process. These hats can be used in predefined orders to reach different goals for the session and one of those goals can be creative problem solving, for which a suitable hat sequence was used in our idea generation workshops.

3 Organized Idea Generation Workshops with Customers

Next the structure of the organized full day idea generation workshops is outlined. In all, three workshops were organized with the participating four companies. Companies A and B were both given separate workshops and companies C and D were given one common workshop. The earlier produced five design themes were assigned to the workshops according to Table 1. All workshops were attended by five employees of the company/companies from different roles in the production process. One of the authors served as the workshop leader and facilitator while several members of the project team attended the workshops as observers.

Table 1. The organized workshops with respect to the design themes and idea generation method used for each theme: B=Brainstorming, 635=Variation of method 635, 6TH =Six thinking hats

Design theme	Companies C & D	Company B	Company A
Communications	B	635	6TH
Documents and tools	635	B	
Changes	6TH		
Fragmentation		6TH	B
Trust			635

Each workshop had the following structure:

1) Introduction of themes and definition of the design problems,
2) Idea generation using each of the three methods followed by rating the ideas, and
3) Review of all top-rated ideas.

First part included three semi-structured discussions where the three design themes selected for that workshop were presented separately and a common understanding of the goal for the creative problem solving was formulated as a problem statement. These discussions lasted for a period of 50 minutes.

Each theme was then dealt by the group led by one of the authors as a facilitator with a different idea generation method each in a period of forty minutes. The used methods were classical brainstorming, a variation of method 635 and six thinking hats, in this order. All sessions started with a brief explanation of the method to be used and a short example if necessary. The problem statement formulated before was also repeated.

In brainstorming the participants were given the additional rules on paper and they were also read aloud. During the brainstorming one member of the project team wrote generated ideas on the wall for the participants to see at all times. The facilitator served to remind the participants of the rules and encourage them to generate ideas. In the middle of the brainstorming the participants were instructed to take a break and think about the problem statement and write down ideas that come to mind during the break.

In brainwriting five large sheets of paper were fastened to different walls of the room. The participants wrote on the sheet in front of them three ideas in a period of five minutes after which they moved on to the sheet of paper on their left. This was repeated so that everyone wrote on every sheet of paper once.

In six thinking hats the current mode of thinking was marked by displaying an accordingly colored paper in front of the participants. The facilitator executed the modes of thinking in the following predefined order:

1) blue hat for the facilitator to state the problem,
2) red hat to discuss the first intuitions regarding the problem,
3) green hat to generate ideas to solve the problem,
4) yellow hat to assess positive aspects of the generated ideas,
5) black hat to critically judge the generated ideas,
6) white hat for sharing and asking for more information on the problem,
7) green hat to generate more ideas to counter the earlier judgments,
8) red hat to discuss emotions evoked by the generated ideas and
9) blue hat for the facilitator to finally state the generated ideas.

Each idea generation session concluded with the participants rating the produced ideas. All participants were given ten distinct stickers to mark those ideas that he/she thought most valuable. A participant could use more than one sticker per idea to indicate the order of preference.

At the end of the workshop the top-rated ideas were further discussed with the participants in order to reach a common understanding of the ideas and their interpretations.

4 Results

The following chapters depict the analysis of the data collected from the idea generation workshops, which included video and audio recordings of group discussions, classical brainstorming and six thinking hats sessions as well as the idea sheets produced in brainwriting sessions. The results include detailed quantitative analysis based on the performed rating and idea yields with the different methods.

4.1 Analyzing the Workshops

The audio materials and the idea sheets were reviewed and distinct ideas were collected based on predefined criteria. An idea was defined as a verb-object phrase that represents a solution relevant to the problem statement. In other words, an idea expresses a thought in a meaningful, relevant and unique way. An idea was considered unique if it had not appeared earlier during the workshop or it was an elaboration of a previously stated idea.

Next the extracted idea collections were united to create a baseline for each session to compare and evaluate the effectiveness and output of all the idea generation sessions. The analysis was mainly concerned with the number of unique ideas relevant to the theme at hand and the judged quality of the ideas by the system development team.

Three members of the system development team rated the ideas together on a ten step scale which entails the idea quality together with information whether the idea was already implemented or partially implemented in the system (see Fig. 1). From

Fig. 1. System developers rating the 308 generated ideas

the system developers point of view the idea's quality was seen as the feasibility of an idea to be implemented and the level of an idea meeting the design criteria; those high on either scale were *selected*. Likewise, unrealizable or otherwise unacceptable or out-of-scope ideas were considered of poor quality and were classified as *rejected*.

The ratings using the stickers done by the participants in the idea generation sessions were not included in the analysis, because during the idea extraction the individual items were split into multiple ideas according to our definition of a unique idea and also reviewing the recordings added several dozen ideas to the lists assessed during the workshops.

4.2 Workshop Results

Table 2 presents the overall number of generated ideas and the results of the rating process. *Selected* ideas are those ideas that the members of the system development team rated as feasible and meeting the design criteria. These include already *implemented* ideas. *Rejected* ideas were those rated by the developers as unrealizable,

Table 2. The number of ideas generated in the workshops

Workshop	Quantity	Quality*				Implemented**
		Selected		Rejected		
		n	%	n	%	
A						
Group discussion	17	13	76 %	2	12 %	9
Brainstorming	39	25	64 %	3	8 %	7
Method 635	54	27	50 %	1	2 %	10
Six thinking hats	20	9	45 %	5	25 %	3
Total	130	74	57 %	11	8 %	29 (39%)
B						
Group discussion	7	3	43 %	0	0 %	1
Brainstorming	20	3	15 %	5	25 %	2
Method 635	50	31	62 %	5	10 %	9
Six thinking hats	16	11	69 %	0	0 %	7
Total	93	48	52 %	10	11 %	19 (40%)
C&D						
Group discussion	10	5	50 %	0	0 %	0
Brainstorming	21	15	71 %	1	5 %	7
Method 635	36	26	72 %	0	0 %	11
Six thinking hats	18	11	61 %	2	11 %	1
Total	85	57	67 %	3	4 %	19 (33%)
All workshops	308	179	58%	24	8%	67 (37%)

* as rated by the system developers in consensus

** in parentheses the percentage of *implemented* out of *selected*

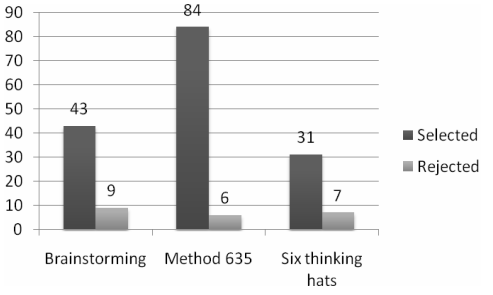

Fig. 2. Overall quantity of selected and rejected ideas produced by different idea generation methods

unacceptable or out-of-scope and thus of poor quality. *Implemented* ideas are already included in the current system or can be realized with the current system or are already approved to be included in future releases.

Several direct observations can be made from Table 2. The different methods were variably suitable for different groups. Workshop A did not excel using the six thinking hats method and produced a low number of selected ideas and a large percentage of rejected ideas. Respectively, Workshop B failed to get good results with brainstorming. Workshop C&D, combining attendants from two companies, delivered clearly the best Selected-Rejected ratio of all the groups.

Method 635 came out as a clear champion. It produced twice the amount of selected ideas compared to brainstorming, and almost three times more than the six thinking hats as shown in Fig. 2. Some of this is due to the fact that method 635 tends to produce a large almost fixed amount of finer-grained ideas, while six thinking hats seemed to assess fewer aggregate collections of ideas.

5 Conclusions

Our analysis shows that with sufficient and knowledgeable moderation non-designer groups previously unfamiliar with creative problem solving methods can be coaxed to generate coherent ideas to fuel product concept development. Even though in our case method 635 was found to be a superior idea generation method, we would recommend using several methods from both the safe and secure paradigm-preserving methods and from the more adventurous paradigm-stretching or breaking methods. This variation of methods also activated the participants kept them more engaged in consecutive idea generation sessions.

Also including members from more than one company, i.e. introducing previously unfamiliar people to a single idea generation session, improved the quality of the produced ideas. Our conclusion is that the participants had to state their ideas more clearly in order to explain their thoughts to strangers. Their more reserved approach also produced significantly less rejected ideas, while the overall number of ideas was, somewhat unexpectedly, not affected.

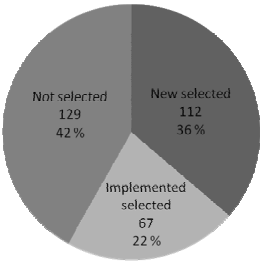

Fig. 3. Usefulness of the produced ideas based on quality and novelty

The distribution of all the produced ideas is illustrated in Fig. 3. From the total of 308 ideas 179 (58%) were selected and approved for further development. Even though a fifth of these ideas was already (partially) present in the product, a remarkably large portion of the generated ideas was still new and useful for the continuing development effort. From a research point of view it can be seen as unfortunate that the system development team's rating did not reveal the amount of completely novel ideas; however, the number of 112 (36%) ideas previously not included in the product development and as such highly potential candidates for new product features, can be considered very promising.

Acknowledgements. We would like to thank all the research and industry partners in the TuoHa II research project: Lappeenranta University of Technology (LUT), Kymenlaakso University of Applied Sciences / KymiDesign, Tieto (TietoEnator) and the participated Lean System customers. The reported research project has been funded by Finnish funding agency for technology and innovation Tekes and Tieto.

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