Being More Creative in Requirements:
An Overview of Creativity Techniques in Literature

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Abstract. Being creative in generating requirements is key in Requirements Engineering. By using creativity techniques for that purpose, ideas can be generated, selected, and implemented easier in order to produce requirements for systems. This position paper discusses various creativity types, techniques and tools in literature. Furthermore, results from previous workshops and experiments are discussed.

1   Introduction

Today's technology allows us to achieve complex applications. Systems such as cyber-physical systems coincide with our physical world, and require a lot of physical world observation, use case generation and software engineering within it. To deliver the requirements that such systems needs, and to provide novelty and usefulness in doing so is achieved by requirements engineering (RE). RE is a process that is often done in the beginning of every project to analyze, elicitate, specify, and manage requirements a system needs at the user-level or the system-level [1]. However, we know that RE is an ongoing process through the whole project steps in order to manage unambiguity in requirements while a software is being developed [1].

Although creativity was related to many subjects in various disciplines, RE hasn't been officially recognized as a creative process of gathering system specifications until mid-90's [1, 2]. The cruciality of creativity was stated by Maiden [3]. The main reason that creativity is of most importance in requirements engineering is due to the fact that software is often a progress of innovation and novelty [3]. In order to provide the innovation and novelty that a product could offer, creative problem solving techniques are required. Today, creativity and creative problem solving are seen as the resources to generate solutions for complex problems, and to create innovative products [3]. Despite the fact that creativity in RE was not supported before, we now have many collections of theories, models, processes and tools in order to solve our problems using creativity [4]. Furthermore according to Stenbergs description of creativity, *the ability to produce work that is both novel (i.e. original, unexpected) and appropriote (i.e useful, adaptive concerning task constraints),* we know now how the creativity in the discipline of RE is assessed [5].

There are at least more than 100 creativity techniques to support creative idea and requirement finding [6]. However, in academia or in practical work, only a few of those creativity techniques are being used. A derivation from the workshop done by Svensson et al. [3] could teach us that a possible reason for the lack of the number of creativity techniques used in practical work or in academia might be the fact that people are unfamiliar with those techniques or that some of those techniques are hard to apply.

The creativity techniques that are mostly used in RE workshops or project meetings are often categorized using 3 main category: (1)-exploratory, (2)-combinational, and (3)-transformational [3, 4]. In this paper, these three categories are taken into account in order to discuss the creativity workshop process, techniques, and creativity tools. Furthermore the view on creativity techniques and their efficiency in both generation of the most number of requirements and generation of the most creative requirement are addressed using the results from workshops; while looking from the position that easy to understand and easy to apply techniques are the best in obtaining the most creative requirements. These techniques such as brainstorming are generally belong to the exploratory creativity and are more efficient, since people are not familiar with divergent thinking, and other unfamiliar techniques.

2 Encouraging Creativity in Requirements Engineering

In order to encourage creative thinking and idea finding in RE, several types of evaluation methods are used [1]. These evaluation methods involve experiments, case studies, and workshops. Especially in supporting collaborative creativity, workshops are used. Svensson et al [1] compares several workshops and their results. In [3], they say that workshops that they manage were able to produce new creative requirements for some industrial projects. We can derive from [1] that every workshop has different measures in assessing creativity, e.g while in the workshop Jones et al and Schlosser et al [7, 8], they assess creativity by the measures of novelty, importance, and customer satisfaction; Mich et al [9] addresses the creativity measure of the workshop as the number of generated ideas.

A good and coherent example of workshop is presented by Svensson et al [3]. They used RESCUE process [10] in their workshops. Furthermore, they assess the quality of creativity by the definition of Stenberg (as described in Section 1). In their study, they organize workshop in 34 different places, using subject students and industry people. In total, they were able to collect 708 user stories in both user-level and system-level combined. Later on in this paper, some of the results of their work will be discussed.
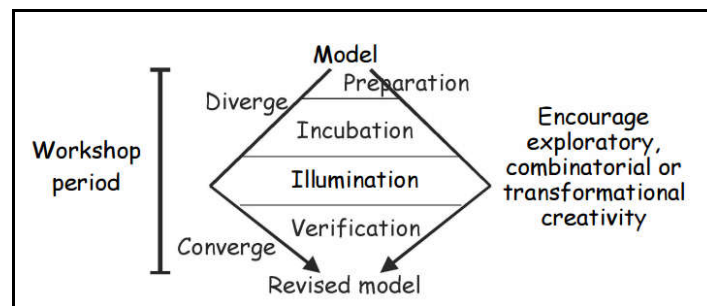
2.1 RESCUE Creativity Workshops

RESCUE is a process of modeling and analysing a system concurrently, in which many processes take place [11]. First process is to consider how people behave, in order to model the activities of people on the system that is going to be developed [11]. Secondly, goals of the system are modeled to obtain the stakeholder goals, and

the main objectives of the system [11]. At the third process, user scenerios and use cases are achieved in order to communicate with the stakeholders easily [11]. Finally, requirements are managed and quality checks are imposed into requirements document [11].

In most of the creativity workshops, RESCUE process is applied. In [11] Maiden et al reports that usage of RESCUE in creativity workshops has 3 crucial aspects, that are:

- Encouraging 3 creativity types that are exploratory, combinational and transformational creativity [12].
- Support diverging from or converging to the main scope of the system [11] to have deviational ideas.
- As stated by Poincare [13], usage of creativity processes -preparation, incubation, illumination, and verification- are important.

A RESCUE creativity workshop model is given in Fig 1 [11].

Fig. 1. RESCUE creativity workshop model

3 Creativity Types and Techniques

As stated in section 2, there are 3 creativity types -exploratory, combinational, and transformational-, each having different applications of creativity techniques. However, it is important to mentioned that there are different opinions in characterizing creativity techniques, e.g. Grube et al [14] characterized the creativity techniques as exploratory, combinational, transformational, and validational. The creativity techniques that are mentioned in academia and in industry often are applied in order to maximize idea finding, rather than specifying the complete requirements [4]. This approach suggests that with creativity techniques, we focus on observing user scenerios and system itself in order to find applicable and novel ideas for the design of a project. For more information, one can see the listing in [15] that contains many creativity techniques and their procedures. Although arguable, the listing [15]

specifies the categories of creativity techniques to be idea generation, idea implementation, idea selection, problem definition, and processes.

3.1   Exploratory Creativity

Exploratory creativity involves creativity techniques in which idea seeking is carried out by exploring different approaches [12]. It is defined by Svensson et al [1] as the generation of ideas by the adaptation of ideas using analogy. There are a number of exploratory creativity techniques in academia such as Hall of Fame [3], brainstorming, sticking dots, snowball technique, free association, story writing, and keep a dream diary [4]. Furthermore there are some creativity fostering techniques in literature such as EPMcreate [9] and POEPMcreate [16, 17] that are based on Elementary Pragmatic Model, which is created as a tool to identify relationships among people [16].

All the exploratory creativity techniques use different approaches in generating creative requirements. For example, *Hall of Fame* is carried out by subjects selecting a celebrity and one of his/her quotes to generate requirements; whereas in *brainstorming*, -the most famous creativity postering technique- subjects generate ideas by relating them to the existing ideas [3]. In addition, Maiden et al [4] explains *serial association* as a technique for finding ideas in which associated ideas are generated until a useful idea comes up. Furthermore, *story writing* [4] and keeping *a dream diary* [4] are the techniques in which exploration of ideas and writing them down is an important driver. It is important to mention that we can see that all of these approaches use a common denominator, and that is to gather ideas by exploring various concepts.

3.2   Combinational Creativity

Combinational creativity uses the approach of combining two seperate concepts in order to produce new ideas [3]. There are several combinational creativity techniques that are used in academia or in industrial applications such as *Idea Box* [6], *fixed and random elements* [4], and *selecting multiple random stimuli* [4]. One of these techniques -*Idea Box* technique- is carried out by trying to list options for parameters defined for a challenge, and then trying to combine these options in order to come up with new ideas and requirements [3]. It allows us to explore various combined concepts belonging to a single element in order to generate the requirements. Although this technique is a well-known technique in RE, the workshop done by Svensson et al [3] shows that this technique fails to generate a sufficient number of requirements. In their experiment, Idea Box was the creativity technique that created the least number of requirements. Interestingly, we could derive from their work [3] that this technique failed to produce any system-level user stories.

Another technique as an example that is achieved by this combinatorial approach could be given as *selecting multiple random stimuli*. The procedure for this technique starts with identification of idea criterion, and picking multiple stimulis such as a noun or phrase that catches attention by observing everything around [4, 18]. The

participants, then need to relate this stimulus to original problem domain and generate ideas that are related with the idea criterion [18]. Furthermore on *selecting multiple random stimuli.*, Maiden et al. [4] reports that this technique is well-suited for requirements that are expressed in text form.

3.3   Transformational Creativity

Transformational creativity is a creativity technique type in which people change existing rules in a way that the things that are considered to be impossible are now possible; then try to come up with new solutions [1, 3]. This new solutions can describe new requirements for systems, as it forces us to think unusually. Transformational creativity techniques are evaluated in many literature work such as [7, 19, 20].

Several creativity techniques have been created so far, such as *constrain removal* [21], *assumption surfacing* [15], *boundary relaxation* [15] and so on. All these techniques involve altering or countering certain constraints of the system in order to generate new ideas. For example, in constrain removal, certain constrains for the system are removed in order to find new ideas for the requirements [3]. Another good example for transformational creativity would be given as assumption surfacing. The procedure for this technique starts by identifying a choice, then explaining the reasons why that choice is selected [15]. Then, all the assumptions and their counter assumptions (in this case, transformations) related to this choice are listed [15]. Working with these assumptions and counter assumptions, we then identify the ones with strong relationship and eliminate other pairs [15]. Finally, an evaluation of plausibility of the pairs with strong relationship is carried out in order to find out the requirements [4]. It can be seen from this example that countering the assumptions that belongs to a system might be a good way to generate new ideas and requirements.

4   Tools in Promoting Creativity

To promote creativity in RE, we often use some tools. Those tools allow us to be more creative when finding out the requirements for our system. In literature and web, we can find a lot of tools such as *ART-SCENE* [22], *MindView* [23], and *combinFormation* [24]. For example, *ART-SCENE* is a simple-to-use tool for discovering requirements with scenerios, in which we can specify use cases, generate scenerios from use case specifications, use multimedia to support our requirements, use specific application domains etc [22]. With the help of this tool, we can also generate presentations based on scenerios [22]. Another example of creativity tools could be given as *MindView*. That tool enables us to do mind mapping by using several associations and topologies such as timelining, top-down, outlining, and left-to-right mind mapping [23]. Furthermore, with the tool that is presented in academia - *combinFormation*-, we are able to browse, collect and combine information on the internet [24]. By using *combinFormation*, we can explore the solution spaces for our problems in systems in order to support the process of generating requirements.

5 Discussion on Previous Work

As introduced in the Section 2, there are several workshops done in literature. One of those workshops were reported by Svensson et al [3]. According to their experiment (results given in Fig 2), brainstorming technique produced the most number of requirements, whereas Hall of Fame succeeded to produce most creative (novel and useful) requirements. Furthermore we can also see from Fig 2 that in their experiment, Idea Box was the worst technique in generated number of requirements, and it failed to produce and requirements that are novel and useful (by their measure). For the case of Idea Box, we can comment that the application of idea box can be not easy and practical, since it involves combination of unusual concepts.

Overall Number of Requirements			Requirements That Scored Novelty and Uselfulness Score of 4 out of 5			
Technique	Number of user stories for specific use cases	Number of user stories at system-level	Creativity Technique	Students	Industry	Total
Hall of Fame	97	77	Hall of Fame	31	58	89
Constraint Removal	46	160	Constraint Removal	8	12	20
Brainstorming	126	192	Brainstorming	14	39	53
Idea Box	10	0	Idea Box	0	0	0
Total	279	429	Total	53	109	162

Fig. 2. Workshop results of Svensson et al [3]

For an industry specific case, [1] presents their study for finding the effectiveness of creativity techniques. Their result, shown in Fig 3, suggests that brainstorming is still the mostly used creativity technique in industry, followed by thinking alone. This might be due to the fact that techniques such as brainstorming and thinking alone are the most straightforward and well-known techniques of all.
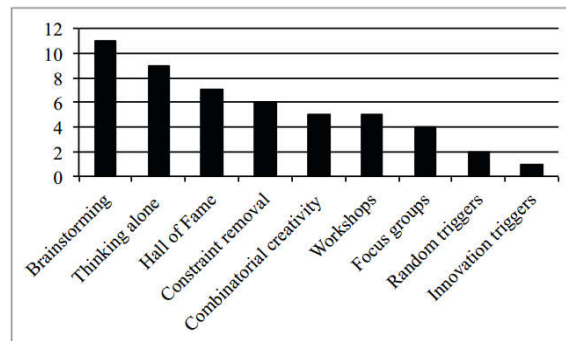

Fig. 3. A case study for the creativity measure of different types of creativity techniques [1]

There are many creativity techniques used in RE to generate new ideas, and find the most novel and useful idea possible. It is believed in this paper that all these creative idea generation techniques could be useful in different contexts. For example,

one might prefer brainstorming to be the most efficient technique while other person is comfortable with Hall of Fame technique in finding the efficient requirements.

We see from the workshops from Maiden et al [3], Mich et al [17], Sakhnini et al [9] and Svensson et al [3] that an evaluation of creativity techniques might produce different results. For example, In [3], brainstorming is reported to be not the best but one of the most creative requirement techniques, whereas [17, 9] presents that brainstorming is not as creative as most of the creativity techniques. Another example of this situation could be that constraint removal technique is found to be a successful creativity technique in the work of Maiden et al [4], but was not as effective in the work of Svensson et al [3]. To this end, we can say that the reason why all workshops do not produce the same result can be due to many factors. These factors might include subjects' state of mind, subjects' familiarity with the techniques or with the domain, or mistakes in evaluation etc. Therefore, we can by no means claim that one single creativity technique is the best. However, we can learn from workshops that some creativity techniques are most efficient for the average subjects. In RE, we can consider the lessons learned from these workshops and try to apply an efficient creativity technique for the scope of our project in order to promote creativity, and to satisfy the stakeholders' needs.

6   Conclusion

Creativity is a process of providing novelty and usefulness and is a key aspect in RE. Requirements of a system can be found more efficiently if creativity is involved. To that end, we need to use creativity techniques and tools that will provide one of the approaches in creativity, -exploratory, combinational, or transformational- while we are trying to find ideas for solving problems, or exploring the new contexts. There are several techniques presented so far, but we are yet to conclude that a specific technique or tool is the best. Although it is agreed in this paper that in general, the most known techniques such as brainstorming and thinking alone are still used the most effectively in literature or in academia in order to obtain requirements, the effectiveness of creativity techniques will differ in different environments, and for different problems. Nevertheless, this paper concludes that the benefit of using creativity techniques in RE is inevitable for producing and managing innovative products; and the techniques that people are familiar with , such as exploratory creativity techniques, are the techniques that they are most efficient in finding creative ideas.

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