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Understanding Problem Solving in Requirements Engineering: Debating Creativity with IS Practitioners

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Abstract

RE is well-recognised as a creative problem solving activity by the systems development community. However, while substantial research has been conducted and knowledge gained about creativity in the general psychology of problem solving, creativity as it applies to RE remains a relatively unexplored area - one that has neither been comprehensively studied, nor highly recognised, as a research topic of importance. This paper attempts to address the abovementioned gap by presenting findings from a recent focus group study of creativity in RE as perceived by a group of RE practitioners. We provide a conceptual framework for understanding creativity in RE, which may be of use to requirements engineers attempting to enable more creative approaches and results, as well as adding to the existing, limited body of research in this area.

Keywords

Requirements Engineering, Creativity, Problem Solving

1. Introduction

Requirements Engineering (RE) is one of the earlier phases in the systems development life cycle, in which user needs are elicited, analysed, refined and documented. This phase is generally viewed as crucial to the quality of the developed system. The systems development community considers RE a problem-solving activity, in that RE involves intensive, complex, cognitive problem activity, in which the requirements engineer "*is forced to engage in both broader conceptual thinking, as well as focused problem-solving activities*" (Batra & Davis,

1992, p. 87). Moreover, RE is knowledge intensive, requiring not only multiple sources of established knowledge and techniques, but also heuristics, novelty and creativity - see for example the work by Guindon (1990b); Robillard (1999); Maiden and Gizikis (2001); and Robertson (2002).

Creativity, although regarded as important in general problem solving, is neither well understood nor comprehensively studied, in RE. This paper reports findings from a project which attempts to explore creativity in RE as perceived by practitioners in the field – and offers a preliminary conceptual framework for understanding this area. It should be noted, however, that although RE in general touches upon the issues of relevance to business and information technology, this paper focuses primarily on the role creativity plays in influencing the IS development process and its direct products rather than in altering the underlying business processes. The findings of this paper can then be used by requirements engineers to gain new insights into the ways of stimulating generation of creative solutions in their clients and to create working environments to support IS development processes, fostering the creation of novel solutions and ideas in RE. Although there exist modern information systems methodologies, such as UML and RUP, which directly underpin the RE processes, our research does not aim to amend or extend any particular methodology to support the generation of creative solutions. The methodologies are varied and have their own unique ways for the development of information systems. This research is simply a starting point in exploring the role of creativity as a part of the RE process, in general.

The structure of the paper is as follows. Section 2 describes the research approach. Section 3 discusses a conceptual framework for understanding creativity in RE. Section 4 concludes the paper.

2. Research Approach

2.1 Research Method

Considering the exploratory nature of our study and the broad domain we attempt to address – namely, creativity in requirements engineering, a field as yet unassociated with a set of clearly identified or accepted issues - we selected the focus group (Kreuger, 1988) as our research method, in order to draw key areas and issues from a group of RE practitioners.

Krueger (1988) suggests that debate and the prioritisation of issues - obtained from a focus group of stakeholders - are useful for identifying key issues in a topic area. A focus group is a qualitative method, positioned somewhere between participant observation and in-depth interviews (Morgan, 1997), and often termed a group interview. A focus group session consists of a semi-structured panel discussion between a small group of people representing a specific target audience - for example, key stakeholders. The panel provides a relaxed forum for discourse, enabling the exchange, exploration and testing of ideas, feedback, brainstorming and discovery, while generating valuable qualitative research information representing critical client interests (Edmunds, 2000; Greenbaum, 1998; Morgan, 1998a; Morgan, 1998b; Morrison, 1998; Templeton, 1996). Discussions are led by a moderator, whose role is to tap genuine feelings and issues about the research topic, while retaining impartiality on the issues.

While the focus group has remained a popular marketing research method for many years, it is still an emerging technique in information systems (IS) research (see examples of use in the

work by Hasan and Tibbits (1999), Law and Lee-Partridge (2001), and Lichtenstein (2000)). In exploratory IS research, there is often a broad research domain to investigate, in which the many issues, questions and relationships of interest to the researchers are as yet unidentified. There is opportunity within a focus group to elicit otherwise obtuse patterns, themes and issues, via the dynamic discourse and debate that are integral to group interviews. In our study, a focus group was employed to gather opinions and comments from RE practitioners with respect to the relevance and occurrence of creativity in everyday practice.

2.2 Research Design

Prior to conducting our focus group, we conducted a comprehensive and critical review of the literature in relevant domains, primarily considering the fields of psychology of general problem solving and RE. Recent understandings of creativity and associated issues yielded a set of issues which we intended to explore via the focus group.

As our moderator, we selected an academic with in-depth knowledge of the research area - and as participants, five experts employed at Australian companies, having significant experience with RE practice: a senior CRM manager from a large bank; a systems analyst from a medium size consulting company; a senior systems analyst from a large IT consulting firm; an IT consultant from a large IT consulting firm; and a systems designer from a large telecommunications firm. The meeting took place as a two-hour session in May, 2002, and was video-recorded and audio-recorded for subsequent study. Brainstorming, debate and the free flow of ideas was encouraged by the moderator, and a lively, bright session ensued as a result (Cybulski, Nguyen, Thanasankit, & Lichtenstein, 2002).

The first half of the session explored creativity in RE as a 'black box', asking participants to describe examples of IS projects conducted in their organisations which necessitated truly creative solutions. It was hoped that this would allow barriers and facilitators to emerge. The second half of the session focused on exploring the topic as a 'white box', asking participants how they went about solving constrained or unusual problems requiring creative solutions, during RE. It was hoped that this would shed light on the nature of the creative process itself, in RE.

To analyse our data, we employed content analysis combined with 'script annotation' (Catterall & Maclaran, 1997, p. 179). The focus group tapes and videos were replayed a number of times and analysed, with patterns, themes and issues emerging. The following section presents a preliminary conceptual framework, based upon our results.

3. A Framework for Understanding Creativity in RE

Creativity manifests itself in diverse disciplines – for example, Fine Arts, Literature, Engineering, and Science - and is also found in the everyday activities of adults and children. While creativity understandings and models proposed for these fields vary (Boden, 1992; Csikszentmihalyi, 1997; Gardner, 1993; Mayer, 1992; Wallas, 1926), this investigation considers only those aspects of creativity which affect IS development - in particular RE, which we specifically view as a problem-solving activity. We therefore analysed data and identified findings in terms of the well-recognised elements of problem-solving activity - *context*, *outcome* and *process*.

Figure 1 suggests that a creative *process* takes place in some problem-solving environment - in our case, a business context within an organisation. The environment defines an immediate

context for a collection of *problems* (stated as business needs), their possible *solutions* (specified as system requirements), and a set of *forces*, which impede the effective problem-solving activities. A valid solution proposed by the *requirements engineer/problem solver* could be judged by the problem *stakeholders* as creative, when some of its properties are considered incompatible with the stakeholders' expectations, thus contradicting their accepted *dogmas*. Such dogmas, in general, guide people's actions by prescribing standards for the solution look-and-feel, form, content and structure, models and processes, procedures, practices and patterns - all of which are deemed to result in solutions which are acceptable, effective, efficient and conformant.
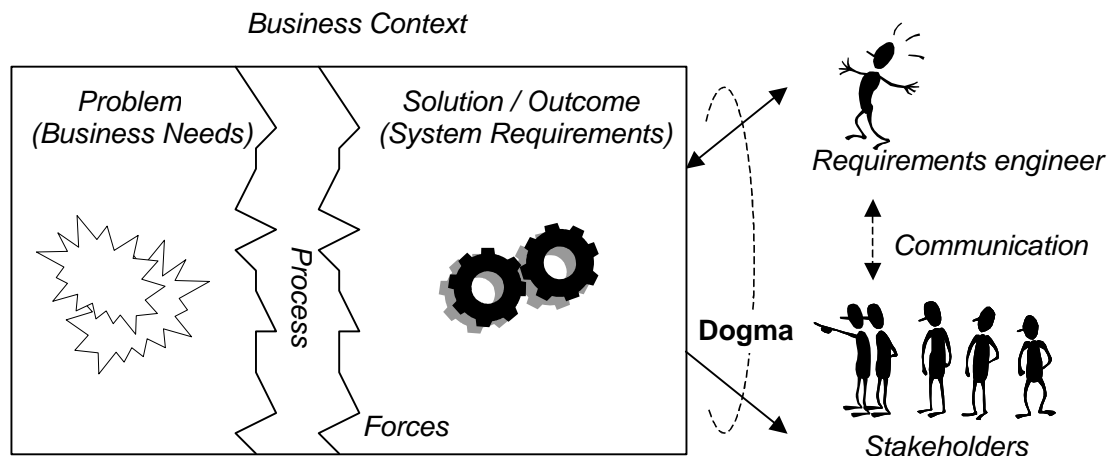

Figure 1. Creativity in RE: Outcome, Process and Context

3.1 Context

Most IS projects are initiated as a result of: problems with, or the updating of, existing systems; developing new information systems; or, the need to address new user requirements or government regulations such as GST (goods and services tax). The development team uses such new system requirements as a basis for further investigation of in-depth requirements - including identifying users for interviews, collecting documentation and identifying project boundaries. These activities are considerably influenced by each individual developer's (i.e. *requirements engineer* in Figure 1) prior knowledge, experiences, individual creativity capability and education.

3.1.1 Individual Dimension

A requirements engineer's knowledge of the issues can be traced back to his/her experience in solving similar types of problems. This knowledge and experience would assist requirements engineers in identifying users and areas requiring further investigation, whereas requirements engineers lacking such knowledge and experience may proceed in considerably different ways. The requirements engineers' prior experiences and mistakes would also improve their ability to employ new tactics or creative techniques for investigating and collecting further requirements. Indeed, lack of wide-ranging experience, more than lack of

technical prowess, was perceived by one of our participants as a serious barrier to creative problem solving in RE. [1]

> *PARTICIPANT E (p 15): "One of the barriers I've seen to creativity is people who have got no range of experiences."*

> *PARTICIPANT C (p 15): "You go off on a tangent to try and solve it – this is the creative side of it. You're not ignoring stuff that's done before – I don't think anyone ever really does – everything is based in your own experience of life anyway."*

The creative mind of a particular requirements engineer can also be an advantage in selecting or creating tools and techniques for improving ways to collect and investigate requirements. Cognition also plays a role in influencing individual creative ability, which, in turn, may influence the outcomes of devised solutions. Although genuinely creative people are rare, typical RE tasks can be enhanced via the more commonplace creativity sparks found in many people.

> *PARTICIPANT E (p 15): "I guess I see two different types of creativity. One is a completely original idea – one that has not ever been thought of before. There's not many people that can actually do that – it's very rare. But, there's another layer of creativity which goes on that I see quite often and is quite useful where people can put this, with that, with that, with that, and come up with a new way of combining things that has never been done before. Different connections that have never been seen before. They can make associations with things that have never been made before. And it's not necessarily a whole new brand of thing but a whole new way of organising things and putting things together. That level of creativity is much more common and can be facilitated."*

Education also plays an important role, clearly influencing a person's ability to explore new options for investigating and gathering requirements. Knowledge can be acquired by experience or education, where experience can be viewed as a self taught method gained through real world experiences, while education can be viewed as the result of domain experts sharing their experiences and knowledge. Unfortunately, traditional education does not provide a great deal of creative problem solving.

> *PARTICIPANT D (p 20): "I think it goes back to the way we're taught. The creativity is not emphasised. Perhaps it should be a subject – i.e. Creative Thinking - so that people are taught to think differently and to try to be creative."*

Experience can also enhance creativity in problem solving by employing personal knowledge and creative ability. Clearly, experience, creative ability and education are *individual* assets

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[1]   Quotations from the transcript of the focus group proceedings are used to illustrate the main points of the paper discussion. The quotations are cross-referenced with the statements of the focus group participants (coded as A, B, C, ...) and the page number of the original transcription document (Cybulski et al., 2002).

which a requirements engineer can bring to a project team for solving system problems or building an information system.

3.1.2 Social Dimension

Individuals bring to a project team their own experiences and knowledge of the problem domain. The team discusses and collaboratively analyses the problem in the application domain, involving communication between group members and users when exploring the problem domain and planning how to effectively utilise the available resources and tools to address the problem.

> *PARTICIPANT A (p 7): "So it's the tools, team and really sponsorship."*

Our participants qualified the nature of effective and *creative* teams, identifying the most important factors as team size, trust and the morale of team members.

> *PARTICIPANT C (p 8): "You've got to break it down into small little teams and you can achieve far more than the big huge ones."*
>
> *PARTICIPANT A (p 12): "I've been able to come up with solutions that are really really good, have been when I've been working with someone that I've worked with for a fair while and I know very well, who trusts me absolutely, typically in a two person team."*
>
> *PARTICIPANT C (p 8): "team morale – that thing of linking arms and working together and believing in each other – that's the real way"*

Organisational culture, as seen through its structure and management practices, greatly influences opportunities to inject creative ideas during the IS development process (Couger, 1996; Smith, Paradice, & Smith, 2000).

> *PARTICIPANT B (p 8): "If the culture is large, corporate, bureaucratic, and it has a history of that, then that influences the use of applied creativity."*

Organisational politics, in particular, is generally regarded as a barrier to creative solutions, by directly impacting project time, funding and sponsorship.

> *PARTICIPANT E (p 9): "We are also killed by lack of time. If you don't have the time you can't be quite as creative as you'd like to be. Sometimes you've got lack of funds because being creative means you've got to spend a lot of money. The funds might not be there because people don't believe that you're actually going to provide a business benefit. Lack of sponsorship!"*

National culture has been discussed extensively in respect of its influence on the RE process (Thanasankit, 2002). Culture determines social order, family values and work relationships -

all having strong influences on the exact manifestation of the creative process in people of that culture. It is the younger generation, however, which usually breaks cultural dogmas, and questions the fundamental assumptions of their organisations and related projects.

> *PARTICIPANT E (p 22): "I think it's a product of family norms, cultural norms. You don't question anybody who is in a higher position than you. If the person in charge of you is 20 years older, they've got to be 20 years smarter, and that's not necessarily true."*

> *PARTICIPANT D (p 22): "Younger people are more comfortable asking why? Why are we doing this? Why do we do it this way? Children for example are not afraid to ask why over and over again."*

> *PARTICIPANT A (p 22): "the newer staff – the grads with two or three years experience - have the ideas and they're not afraid to ask questions and keep asking. The middle people are comfortable and seems to be the least creative and have no originality."*

For example, in the Thai culture, characterised by the significant power difference between subordinates and superiors - or even between work colleagues - cultural influence can be a serious barrier to effective communication and generating creative solutions (Thanasankit, 2002).

External forces, such as government legislation and laws, create additional constraints and requirements for information systems. Certain constraints can impose specific technologies to be used in the RE process or in a later development process. These technologies typically include software systems, programming languages, or standards for data exchange with government agencies and business partners. Our participants were particularly sensitive to the use of methodologies, standard process models and tools in projects requiring the creative spark.

> *PARTICIPANT B (p 8): "People tend to fall back on process when there is an absence of creativity, and where there's an absence of creativity and pragmatic approach. Maybe if they don't have the talented people around them or the right tools, people tend to then fall back on methodology."*

> *PARTICIPANT A (p 7): "More so, though that you must work with the right people and the right tools. If you've got the wrong tools, no matter what, you won't be able to be creative. "*

Existing privacy legislation and security needs may further constrain the system. All the above constraints are usually taken as obligatory requirements in the development process, however they commonly reduce developers' flexibility and freedom, thereby limiting possibilities for creative solutions. In many cases, requirements engineers must question the deeply embedded beliefs of individuals and the organisation to determine the real sources of such constraints - with ungrounded constraints rejected, enabling novel solutions to emerge.

> *PARTICIPANT C (p 11): "Step off what the answer is and what the solution is, and start talking about what the issues are, and what you are trying to achieve, and then your requirements are going to follow. Okay, this particular requirement answers this business imperative."*

> *PARTICIPANT C (p 3): "The standard approach wasn't going to work – had been tried so many times before and failed – and they couldn't go down same path over and over again."*

The final process is the selection of the 'best fit' solution which meets all stakeholder requirements and needs for the complete design and development of IS. This stage involves significant communication, negotiation, and compromising of ideas and system functionality. In selecting the best solution, the development team may have to take all of the issues discussed above into consideration, requiring careful evaluation of the individual, social and external factors involved.

The above-discussed socio-organisational *forces (*also depicted as a set of *forces* in Figure 1) significantly affect creativity in RE. These forces can be identified within the RE process as shown in Figure 2.
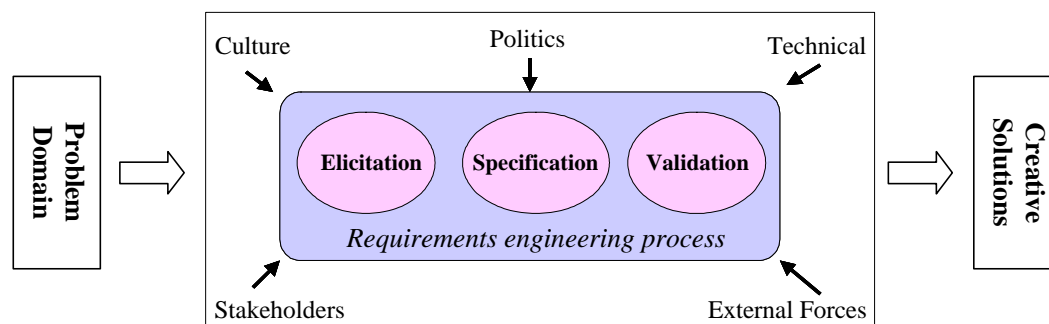

Figure 2. Socio-Organisational Aspects of Creativity in RE

3.1.3 Summary

Problem-solving in RE occurs in a business context which is embedded in a socio-cultural and organisational system. Creativity issues covering both individual and social dimensions were explored. In terms of the individual dimension, education and a wide range of experiences can yield valuable advantages for enhancing the creativity potential of people. This dimension is related to the Person aspect in Csikszentmihaylyi's (1997) system view of creativity. In terms of the social dimension - teamwork, trust, social and organisational cultures, and external forces such as standard methodologies, processes and government legislation, are considered to greatly influence the standard of creative performance of requirements engineers. Teamwork, trust, social, organisational and cultural factors can be related to the Field aspect in Csikszentmihaylyi's (1997) system view of creativity and Couger's (1996) recommendations for fostering creativity within an organisational setting. External forces explored in our focus group appear compatible with the Domain aspect in Csikszentmihaylyi's (1997) work. In future research, we intend to relate the above findings from our study to previous work by Csikszentmihaylyi (1997) and Couger (1996) in order to

understand creativity within the context of problem solving and socio-organisational settings in RE.

3.2 Outcome

The focus group participants clearly believed that individual and team creativity plays a vital role in the RE stage of IS development. When asked to comment on the fraction of projects requiring creative solutions, they provided some startling responses:

PARTICIPANT B (p 13): "100% of all projects."

PARTICIPANT E (p 14): "I can't think of a single part of what we do that doesn't require creativity."

Such comments raise two very interesting questions about the perception of creative IS products, in particular:

What methods promote the development of creative IS solutions?

What features of the resulting RE products make them appear creative?

While organisations strive to introduce creative processes (Smith et al., 2000) or to employ novel technology to enhance creativity in people (Candy & Edmonds, 2000; Shneiderman, 2000), it is ultimately the end product of the development process, which really matters. With a clear focus on the creative outcome rather than the process of IS development, RE provides a sound philosophical framework for investigating creative IS products.

3.2.1 Promoting Creative Outcome

Gause and Weinberg (1989) provide a good starting point for dealing with these issues by defining a *problem* as "a difference between things as perceived and things as desired". This gives a clear indication that a desired *creative solution* can be sought from the commencement of the problem solving activity. Gause and Weinberg (1989, pp 49ff) offer several methods useful in this pursuit, *inter alia*:

- the solution idea - by redressing the existing problem solution;
- the technology idea - by inventing a new problem for the innovative solution;
- the simile - by comparing the solution to a desired analogue;
- the norm - by contrasting the novel solution with the norm;
- the mock up - by constructing the reference object in the absence of the norm;
- the name - by making up names for the objects that do not have them already.

Other authors, such as Downes and Mui (2000) with their concept of *killer applications*, provide a creativity recipe, which in a given field and within some limited timeframe may result in a design of an IS product perceived by the potential users as highly innovative.

3.2.2 Assessing Creative Outcome

Determining the creativity value of new IS products has been the focus of previous research efforts. The novelty and utility of these products are commonly regarded as critical system characteristics for measuring IS creativity (Couger & Dengate, 1992; Massetti, 1996). For the participants of our focus group, the perception of *newness* was certainly a factor in determining the creative value of IS products.

> PARTICIPANT A (p 15): "Original thought – something that is actually ground-breaking – a world first – that's what I believe is being creative."

At the same time, however, software systems are usually developed in environments constrained, as discussed previously, by the organisational and national culture, politics, available technology and stakeholder views. Together with budgetary and time constraints, these factors may limit both the means *and* the ends of the creative cycle. As a result, most software produced is usually comprised of "uninspiring" reused components, which typically possess well-known and already tested features. When such components are combined, however, the result may still 'appear' as a highly creative product.

> PARTICIPANT C (p 16): "I don't really think there are those ideas that no one has ever thought of before. I don't think anything is that ground breaking. I think most things are re-packaged and most people can't see how it's been repackaged. I think it's clever if you can make it look like a brand new idea even though it's based on something else."

Constraints are not always perceived as inhibitors of creativity, but rather as providing boundaries for creative endeavours.

> PARTICIPANT C (p 5): "In relation to creativity, it's difficult to know sometimes where to stop whereas if you have constraints, i.e. time/budget, it gives you boundaries for the creativity."

Working in a dynamic software development environment provides yet another perspective of innovative outcomes, as the software maintenance process and its products can also be regarded as creative opportunities.

> PARTICIPANT A (p 14): "Fixing up someone else's mess, for example, that's not a project to me. You've got to build something brand new, or develop a new system and that to me is a project."

> PARTICIPANT E (p 14): "even fixing up someone's mess – you have to get creative to solve it."

> PARTICIPANT A (p 14): "If you happen to have a blinding flash to see what's wrong with this existing system so that you can actually fix it up, then it can be very creative."

3.2.3 Accepting Creative Solutions

It should also be noted that from the outset, a creative solution needs to be set firmly in the business imperative, which not only provides the context for the solved problem, but also defines the resulting products' audience and perceptions.

> *PARTICIPANT C (p 11): "Step off what the answer is and what the solution is, and start talking about what the issues are, and what you are trying to achieve, and then your requirements are going to follow. Okay, this particular requirement answers this business imperative."*

It should be stressed that creative solutions do not necessarily result in the most desirable outcomes for the problem owners, such as IS organisations (James, 2002). IS solutions which utilise creative means, but preserve *dogmatic* ends, may not even be perceived as innovative by the IS audience - and thus may be readily accepted. Non-conformance of a solution, however, may lead to users rejecting the cost (in broad terms) of any impact resulting from its acceptance. Such cost may be incurred by the disappearance of selected problem requirements and essential constraints, or as a result of environmental change necessary for the facilitation of the solution. All such costs typically lead to lengthy product adoption, and potential changes due to the adaptation, causing such creative products to likely be perceived as more of a liability than a benefit. As one of our participants summarised:

> *PARTICIPANT C (p 8): "What it all boils down to is that you've got to get out there and start providing value very quickly"*

As suggested by DeSanctis and Poole (1994), technology that is rejected by its users, regardless of its novelty or imaginative features, is effectively a failure.

In general, traditional *dogmas* perceived by the stakeholders, such as standards for the solution, models and procedures, practices, patterns, and constraints play a vital role in assessing and recognising a suggested solution as a conformant, effective, efficient and creative outcome. It is also important to note that the creative requirements engineer is able to think outside-of-the-box, and is courageous enough to stand up for his/her dogma-breaking idea:

> *PARTICIPANT C (p 21): "people like me who are prepared to stand up and say this is rubbish – you need to change tack – and succeed. You would be amazed at the level of people I've been in front of and say this is what I think, and they say "great idea" and they do pick it up. You need to be brave enough to stand up and say what you think. [...] You need to be brave to say what people don't always want to hear. You need to get to a point where you say, that's money down the drain, but let's move on."*

3.2.4 Summary

The development of creative information systems is considered a high priority on the IS professional agenda. Adding creativity value to IS can be planned from the initial stages of system development. RE provides methods and techniques which can be applied effectively

in making the software systems *appear* innovative and useful to prospective users, even without a creative development process behind them. While pursuing creative solutions, requirements engineers must be wary of the underlying business imperative that should be addressed in the process, and the short timeframe in which the creative solutions must provide value back to the business.

3.3 Process

Creativity is regarded by many as a mysterious process during which the problem solver comes up with new ideas that solve the problem. In this section, we attempt to explore the creative nature of the RE process. We begin by offering a brief discussion of two schools of thought in general problem solving, and discussing how they relate to the RE process. Next, we present an analysis of data collected from the focus group. Finally, we provide our most recent conclusion.

3.3.1 Understanding the Problem Solving Process in RE

In an attempt to understand creativity within the RE process and to align the traditional understanding of creativity with the RE literature, we examine two popular schools of thought in psychology in problem solving: the information processing theory and Gestalt theory.

The information processing theory describes the problem solving process as a graph of nodes - see for example, Simon (1969), Newel and Simon (1972) and Kant and Newell (1984), in which possible states, depicted as nodes, are situations that may occur as the problem solver attempts to solve the problem. The graph itself shows the searching for a path from a start state to a goal (desirable) state by the problem solver. In other words, the problem solving activity can be described as a systematic and step-wise search process through the problem space (Newel & Simon, 1972).

This understanding of the problem solving process supports traditional RE process models suggested by Sommerville (1996), Loucopoulos and Karakostas (1995), Kotonya and Sommerville (1998), and Robertson and Robertson (1999). Although these models differ in the detailed descriptions, at a high level of abstraction, they tend to describe a process in which the problem space is structured, elaborated and refined in a systematic and incremental manner.

This understanding treats the search for the solution path as if it could be guided by a previous understanding of problem. However, it does not sufficiently reflect the nature of the RE problem. The problem in RE has been argued as ill-structured, characterised by the incompleteness, ambiguity and uniqueness of the problem, the multi-discipline domains and knowledge exploited, the non-deterministic approach to solving requirements problems and the open-ended nature of solutions - see for example (Batra & Davis, 1992; Carroll, Thomas, & Malhotra, 1979; Guindon, 1990b). In addition, Visser (1992) and Guindon (1989) argue that requirements engineers are not given the problem, but construct it during the RE process. Clearly, RE involves a cognitive, intertwined process of problem constructing as well as problem solving (Visser, 1992). Furthermore, Guindon (1990b), Schön (Schön, 1996) and Robillard (1999) argue that solving these types of problems requires novelty, creativity and opportunistic insight, as well as "standard" modelling knowledge and skills.

On the other hand, the Gestalt school (Mayer, 1992; Ohlsson, 1984; Wertheimer, 1959) of thought in problem-solving is based on the notion of insight and problem space restructuring. According to the Gestalt theory, in an attempt to solve a problem, the problem solver explores and analyses the problem space, moves and drifts between different problem areas, and he/she solves the problem usually as a result of an unexpected insight into the problem. Insight is a sudden flash of ideas - a new lead - which usually occurs in an unexpected manner, involves a surprise and solves the problem by restructuring the problem space. The Gestalt psychologists propose that problem space restructuring is crucial in problem solving because the problem is seen in a new way and from a broader perspective.

The Gestalt school is supported by an influential model of creativity proposed by Wallas (1926), Hadamard (1954), and Poincaré (1952). This model describes the problem solving process as cyclic, with each cycle consisting of four stages: preparation, incubation, illumination (insight), and verification. At the preparation stage, problem areas are explored, and ideas and directions formed. At the incubation stages, the problem solver moves away from the problem in hope of reaching a solution. This incubation stage is explained by various authors in different ways, for example refreshing the conscious ideas, (physically) relaxing the brain, or getting rid of false leads and assumptions, letting ideas formed at the subconscious level to break through. The illumination stage takes place when an instant insight occurs, and is often described as "a sudden flash of ideas", "Aha!" or "Eureka" moment. At the verification stage, insight is evaluated and utilised. This, in turn, takes the problem solver back to the first state. This model of creativity is in line with the Gestalt theory of insight.

In RE, the opportunistic characteristic of the problem solving process has been postulated by Guindon (1990a), Khushalani (1997b) and Carroll and Swatman (1999). More recently, opportunism in RE has been confirmed and further examined by Nguyen et al. (2000) and Nguyen and Swatman (2003). They propose the catastrophe cycle RE process model which portrays the RE process as involving adaptive and responsive exploration of the problem space and periodical reconceptualisation of the problem. According to their observations, periodical reconceptualisation of the problem is insight-driven, happens in an unpredictable manner, and involves a significant change of problem perception and the formulation of 'the right' problem representation. This description of insight is consistent with the Gestalt theory in psychology of general problem solving. In their recent discussion about creativity, Nguyen and Swatman (2003) support Wallas's (1926) model of creativity and suggest an approach to facilitating this model within the RE process.

3.3.2 Analysing Data Collected from the Focus Group Session

Data collected from the focus group session show supporting evidence for Wallas's (1926) model of creativity and the Gestalt theory of insight. For example, when being asked about the process or pattern that surrounds the person who works creatively, the participants described:

> *PARTICIPANT E (p 16): "they're engaged in the conversation and involved but at some point, they withdraw – over there – and they go quiet. And they are thinking. Then they come back into the conversation – I have a great idea – they are the ones that often come up with the most valuable solutions. It's almost like they have to withdraw themselves from the debate for a period of time for them to think about what they're doing."*

>*PARTICIPANT A (p 17): "I find I'm most creative when I'm asleep – I find I'm most creative when I meditate. […] What you're doing is you're sort of turning your brain off. You've got to think things through. It's your subconscious that actually thinks things through […] Quite often, if you sleep on a problem, the next morning it will almost certainly be solved. It's the same thing with problem solving […]"*

The above extracts remind us of the incubation stage, described in Wallas's (1926) model.

The illumination stage with sudden flashes of insight was also mentioned in the participants' descriptions of creative ideas. The participants described that the solution came up "*just in a blinding flash. Quite often I'll say 'why didn't I think of that yesterday' *", or "*That's like sometimes when you think you've been completely unproductive over the day and then suddenly out comes the answer in front of you*", or "*a little diamond that goes 'bang' and comes out with an idea to challenge the way people think before*".

Further, the participants also recognised that inputs and different views need to be collected and prepared; this is consistent with Wallas's (1926) preparation stage.

>*PARTICIPANT C (p 19): "So you need to spend a couple of days reading, doing research and letting the ideas flow."*

Interestingly, while describing his experience, one participant referred to the movements of ideas between subconscious and conscious levels which are similar to Hadamard's (1954) argument that insight is a creative idea which is preceded by a previous unconscious preparation process and <u>suddenly</u> becomes accessible at the conscious layer and solves the problem.

>*PARTICIPANT D (p 18): "For me, I need to listen to my subconscious. I find that subconsciously I've generated a lot of hypothesis and not realising I'm doing it. […] I was trying to figure out a solution to a problem and suddenly it just popped into my head. I think it has been floating around in there – I had been generating lots of hypothesis but then I stopped for a second and I maybe withdrew and listen to myself and that's when it came."*

Discussing characteristics of creative solutions, the participants differentiated two types of: "*a completely original idea*" and "*a new way of combining things that has never been done before*". They showed a special interest in the latter.

>*PARTICIPANT E (p 15): "[...] a little diamond that goes 'bang' and comes out with an idea to challenge the way people think before."*

>*PARTICIPANT A (p 19): "[...] that's when you're creative. It's when we link things together. That's when the different connections have to take place in the brain for that to happen."*

> *PARTICIPANT C (p 15): "What I'm thinking is that creativity is kind of like going off on a tangent, so you see an idea and it triggers something [...]"*

The above extracts may be related to what is described in Nguyen and Swatman's (2003) major change of perception or re-conceptualisation which significantly restructures the problem space.

3.3.3 Summary

In summary, the process and pattern described by the participants, support creative characteristics of problem solving as described in psychology and general problem solving literature. While findings from the focus group session confirm and strengthen the insight-driven, highly-creative and opportunistic nature of the RE process postulated by Guindon (1990a), Khushalani (1997a), Carroll and Swatman (1999) and Nguyen et al (2000), "*current work on RE does not recognise the importance of creative thinking in RE*" (Maiden & Gizikis, 2001). Further work is required to examine and to extend our understanding of creativity within the RE process.

4. Conclusion

Summarising, our paper reports findings from a focus group study into the potential for creativity within RE. A conceptual framework for understanding the creative nature of RE was developed, emphasising the following elements of problem-solving activity:

- *Context*: Problem solving in RE occurs in a business context, which is embedded in a socio-cultural and socio-organisational system. Issues pertaining to creativity, covering both the individual and social dimensions, were identified and analysed.
- *Outcome*: A wide range of issues concerned with the promoting, assessing and accepting of solutions in RE problem solving, were explored and discussed. Addressing these issues early in systems development is believed to play an important role in enabling the problem solver to pursue creative solutions.
- *Process*: Findings from the focus group session confirm and strengthen the insight-driven, highly-creative and opportunistic nature of the RE process.

Clearly, creativity is described as an inherent and desirable characteristic in RE problem solving. In an era in which the creative spark or idea - the innovation and inspiration - are the distinguishing aspects of an excellent product, it would behove requirements engineers to increase the attention paid to fostering and managing creativity within RE problem solving. Our preliminary framework suggests an holistic approach to understanding such creativity – one in which context, outcome and process are all taken into account. The dominant concerns appear to be the human and social issues, such as dogmas, culture and politics, reconceptualisation and insight. Therefore, companies should consider how to address these types of issues in a concerted, effective and efficient manner – perhaps as part of an overall creativity program for requirements engineers. For researchers, therefore, clearly a useful next step would be to investigate *how* the desired creativity in RE may indeed be facilitated.

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