

Where Do Requirements Come From?

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What should a product do? What qualities should it have? How do we determine these requirements for new generations of products? Requirements engineering is an activity in which a wide variety of stakeholders work together to answer these questions. But, the answers do not arrive by themselves—there's a need to ask, observe,

of interest in design. For example, IDEO, the innovative design consultancy (www.ideo.com), uses a four-stage method in which design teams try to understand the context of a new product, observe it in real-life situations, visualize it, and then evaluate and refine it.¹ The company's focus is on team-led multidisciplinary creativity and innovation. One of IDEO's most important activities is to determine customer requirements for new designs. However, RE processes—such as brainstorming, simulating, and visualizing storyboard-illustrated scenarios—are second to IDEO's tried-and-tested creative design process, environment, and team structure.



discover, and increasingly create requirements. If we want to build competitive and imaginative products that avoid re-implementing the obvious, we must make creativity part of the requirements process. Indeed, the importance of creative thinking is expected to increase over the next decade (see the sidebar).

Unfortunately, most RE research and practice does not recognize this important trend. In this column, we highlight some important information sources for creativity and innovation and present some useful examples of creative RE as references to guide and inspire readers.

Creative design: Where does RE fit?

Creativity has increasingly been the focus

Current thinking

Lemai Nguyen and colleagues have observed that RE teams restructure requirements models at critical points when they reconceptualize and solve subproblems, and moments of sudden insight or sparked ideas trigger these points.² Their observations support creativity theories from previous work that distinguish between four phases of creativity: preparation, incubation, illumination, and verification.^{3,4} Incubation and illumination are the most important phases. Incubation handles complexity; during this relaxing period, the designer unconsciously and consciously combines ideas with a freedom that denies linear and rational thought. During the subsequent and shorter illumination phase, a creative or innovative idea suddenly emerges, often at the most unlikely time in the most unlikely place. Many creative fields report this “eureka” effect.

Margaret Boden is a leading authority on

cognitive creativity. She identifies basic types of creative processes:⁵

- *exploratory creativity* explores a possible solution space and discovers new ideas,
- *combinatorial creativity* combines two or more ideas that already exist to create new ideas, and
- *transformational creativity* changes the solution space to make impossible things possible.

Most RE activities are exploratory. They acquire and discover requirements and knowledge about the problem domain. RE practitioners have explicitly focused on combinatorial and transformational creativity in RE, although we can construe some research (such as analogical reuse of requirements)⁶ as creative design.

Mihaly Csikszentmihalyi identifies three social contexts that influence creativity: domain, field, and person.⁷ The social environment as well as cognitive processes influence creative thinking. IDEO recognizes this with its greenhouses—carefully designed office spaces that encourage creative thinking by imposing as few

rules as possible.¹ The authors have applied these ideas by running a series of workshops to promote creative design during RE. In each workshop, stakeholders work with design experts to envision ideas that could later provide the basis for further requirements.

An example

Computerized systems for managing air traffic are becoming increasingly complex, and we need new approaches to cope with future demands and to use technology effectively. We are working with Eurocontrol's Experimental Center in Paris to design and implement an innovative process for determining stakeholder requirements for a system called CORA-2 (Conflict Resolution Assistant). This system will provide computerized assistance to air traffic controllers for resolving potential conflicts between aircraft.

We have designed an RE process with three concurrent, independent activities to determine the stakeholder requirements, generate creative designs, and model the system's cognitive and work context. We keep these activities independent to avoid overcon-

straining the CORA-2 requirements. Instead, we trade off requirements and design ideas at predefined synchronization points. The resulting design alternatives provide the basis for a systematic scenario-driven process for acquiring and validating stakeholder and system requirements.

We encourage creative thinking by holding workshops. We design each workshop to support four essential processes (preparation, incubation, illumination, and verification) in creative thinking.

To prepare stakeholders, we maintain a regular dialogue between workshops through email to encourage them to discuss creative processes and ideas from earlier workshops. In each workshop, we encourage ideas to incubate using techniques such as sponsoring presentations from experts in non-air-traffic-control domains, playing games to remove people's inhibitions, listening to music and discussing paintings, and making airplanes from balloons. Shorter, more intensive periods follow each incubation period to illuminate ideas. People work together in dynamically designed groups to generate new ideas

Creativity: The Next Big Thing

Historically, the industrial revolution replaced agriculture as the major economic activity, and then information technology replaced industrial production. Now the Nomura Research Institute in Japan predicts that information technology will be replaced with a new dominant economic activity focusing on creativity (see <http://members.ozemail.com.au/~caveman/Creative/Admin/crintro.htm>). The shift of IT organizations toward the creative sector and companies striving to design innovative products that combine and use existing technologies in unanticipated ways is beginning to justify this prediction.

In the literature on creativity, we identify three models that describe the creative process's characteristics:

- Graham Wallas's model describes creativity from an individual's point of view and defines the four cognitive phases of a creative process;¹
- Margaret Boden's definition distinguishes three types of creativity and examines the difference between creativity and novelty;² and
- Mihaly Csikszentmihalyi's model captures the socio-cultural characteristics of creativity by describing how it occurs in a domain of knowledge and rules.³ It outlines the transfer of knowledge between domain and individuals and the contribution of individuals to the domain. This model strongly represents the social environment required in modern problem situations.

Elsewhere, Robert Sternberg reports a thorough and focused collection of chapters focusing on major psychological approaches to understanding creativity.⁴ Teresa Amabile's research is useful for its numerous summaries.⁵

References

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building on the previous creative process cycle. In later workshops, we also encourage idea verification by asking stakeholders to assess, rank, and categorize new ideas in different ways. We repeat this process several times in each workshop. To guide the participants during these processes, we used Roger Von Oech's explorer, artist, judge, and warrior roles to focus them on specific activities.⁸

One of these workshops' most prominent features is that we invite experts from domains that have similarities (not necessarily obvious at first) to aircraft conflict resolution to support idea incubation. To encourage insight into the conflict resolution domain, we invited experts in Indian textile design

and modern music composition. Similarly, to explore candidate design ideas as fully as possible, we invite experts in creative systems design, brainstorming, and information visualization. Finally, to incubate creative combinations of these design ideas, at one workshop, we invited one of London's top fusion chefs to talk about combining unusual ingredients and to demonstrate fusion cooking in the workshop. The resulting *pâté de foie gras* with bruschetta and mango chili salsa was an unlikely but delicious combination.

The result of these workshops has been to inspire pilots, air traffic controllers, administrators, managers, and developers to work together and create new ideas. We have learned

that by exploiting even simple creativity models, we can promote significant levels of creative thinking about requirements and candidate designs for an air traffic control system. We look forward to reporting these results more fully in the future.

We believe that RE is a highly creative process, and economic and market trends mean that it will become much more creative. Unfortunately, current work on RE does not recognize the critical role of creative thinking. We have argued that you should recognize the importance of creative thinking in RE, and we recommend useful information sources for people who wish to know more about creativity. Furthermore, we invite readers to contact us with their thoughts or experiences on the subject or to find out more about our creative RE process. 

References

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