Guest Editor's Introduction

THE ESSENTIAL TENSION OF CREATIVITY AND RATIONALE IN SOFTWARE DESIGN

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Creativity and rationale connote two faces of design that are sometimes viewed as complementary: envisioning new worlds through intuitive strokes of innovation versus analyzing reasons and tradeoffs to guide the development of new artifacts and systems. Because it is frequently the case that different practitioners and researchers, and different design disciplines, prize one or the other more highly, there is not only a contrast, but also a lack of integration between creativity and rationale.

Yet looking at the two, it also seems they are indivisible: What would be the point of building and/or using rationale in design if doing so were to result in anything other than greater creativity? And almost analogously, what good would be served by cultivating or purporting creativity that could never be interrogated, understood, or deliberately improved and applied, never be explained or conveyed to colleagues, never be passed on to students?

On the other hand, this is most definitely not to say that the only reason for rationale in design is to enhance creativity, or that sources of creativity that cannot be explicitly articulated (put into words) have no value. Rather, it is to say that designers and design researchers should want rationales and rationale practices that enhance creativity, and should want to be able to understand and to explain their use of creativity to students, to clients, to users, and to other stakeholders.

It is not hard to state how creativity and rationale could fail to have a mutually facilitative relationship. Rationale can easily become an obsession of documentation and formalization, excessively detailing issues, arguments, and alternatives to an extent or in a manner that no one would ever want to revisit, let alone create in the first place. And indeed, rationale practices are often cited as exemplifying a classic rationalist *mis*understanding of what design is about and how it moves forward. Rationale practices that suffocate design by enforcing a tedious documentation burden could appropriately be regarded as undermining possibilities for creativity.

But creativity has its challenges as well. It is sometimes characterized as necessarily arcane, inherently ineffable, and slightly (or even primarily) mystical. But this attitude unambitiously conflates the nuance and intellectual rigor required to pose and investigate subtle questions with reluctance to pose questions at all. It makes it a point of definition (or

perhaps religion) that creativity cannot be fathomed or explained simply. It is true that such a view of creativity would have few or no implications for understanding, teaching, or practicing design. But we are not forced to this view. Perhaps, like learning, emotion, sociality, and other characteristically human capacities, creativity is embedded in activity, difficult to isolate for analysis, but quite real and principled.

Ironically, and tragically, research on creativity may have inadvertently vindicated the tendency towards know-nothing views of creativity by considering it in austere generality, and (perhaps as a result) producing fairly ethereal and obvious characterizations, for example, the somewhat underwhelming chestnut that creative activity requires both divergent and convergent thinking.

Given how easy it is to imagine, or just to see in the world, that creativity and rationale can have little to offer one another, it becomes all the more interesting to ask whether and how creativity and rationale can have mutually facilitative interactions.

A WORKSHOP ON CREATIVITY AND RATIONALE IN SOFTWARE DESIGN

A diverse group of designers and design researchers met at Penn State University, June 15-17, 2008, to exchange perspectives and approaches, to articulate and develop new research ideas and hypotheses, and to reconsider and reconstruct prior work and results toward new research directions.

The workshop included thought leaders from several software design research communities, such as human–computer interaction design, sociotechnical systems design, requirements engineering, information systems, and artificial intelligence: Mark Ackerman, University of Michigan; Eli Blevis, Indiana University; Janet Burge, Miami University of Ohio; John Carroll, The Pennsylvania State University; Fred Collopy, Case Western Reserve University; John Daughtry, The Pennsylvania State University; Umer Farooq, The Pennsylvania State University; Gerhard Fischer, University of Colorado; Jodi Forlizzi, Carnegie-Mellon University; Batya Friedman, University of Washington; John Gero, George Mason University; Steve Harrison, Virginia Tech; Sal March, Vanderbilt University; Raymond McCall, University of Colorado; Rosalie Ocker, The Pennsylvania State University; Colin Potts, Georgia Institute of Technology; Mary Beth Rosson, The Pennsylvania State University; Al Selvin, the Open University and Verizon; Alistair Sutcliffe, University of Manchester; and Deborah Tatar, Virginia Tech.

The workshop premise was that creativity and rationale should not be opposed worldviews, and that coordinating them and integrating them is a key to having more effectively reflective design practices, and absolutely essential to a serious science of design. Discussions of design in the computer and information science and engineering (aka CISE) disciplines are highly compartmentalized. In software engineering, design is often discussed as if it were nearly algorithmic, whereas in human-computer interaction it is often treated as nearly ineffable art. At a finer level, critical concepts like *rationale* and *creativity* are understood in multiple incompatible ways. Thus, rationale can be a designer's inchoate intent, an analyst's inference about overall intent or significance, a comprehensive representation of the design process (e.g., IBIS; Kunz & Rittel, 1970), or a detailed (e.g., propositional) representation of consequences for various sorts of users (elaborated by empirical results; Moran & Carroll, 1996). Similarly, creativity can refer to the personal experience of being creative (e.g., flow, Csikszentmihalyi, 1996; or eudaimonic well-being,

Ryan & Deci, 2001), it can refer to the novelty of strategies and practices employed in design as problem solving, it can refer purely operationally to the proportion of novel ideas generated, or it can refer to the novelty of artifacts and other embodied products (cf. innovation; von Hippel, 1988).

The workshop started with seven orienting questions:

1. When and how can design rationale evoke creativity in design? For example, does/can design rationale function differently (more effectively) in end-user design, participatory design, pair programming/agile design, or open source design communities?
2. When and how can design rationale fail to evoke, or even undermine, creativity?
3. How can the construction of design rationale be construed and experienced as a creative activity? And how can this be enhanced?
4. What tools and methods for rationale can support or enhance the creativity of design products? For example, how much structure should design rationale tools provide/impose to maximize creative outcomes (e.g., contrast QOC, gIBIS, and design blogs).
5. How might valuing the creativity of rationales inspire new forms of design rationale? What would be characteristics of such new forms of rationale?
6. How can design rationale be used in the classroom to motivate and instruct students about reflection, idea generation, and evaluation?
7. What are useful models, theories, and frameworks for understanding and managing the relationship between rationale and creativity in design?

We specifically eschewed starting from definitions: That is such a formulaic workshop activity after all, and can implicitly filter out diversity of positions. But definitions of course crept in. To understand the relationships between creativity and rationale in design, perhaps one must fix a conception of design, creativity and rationale, at least to some extent.

We characterized design as involving the construction of frames or worlds within which designers work. The scope of this construction is broader than merely an artifact. It encompasses the designer's values and intentions, assumptions and knowledge about people and their activity, and the palette of materials and components that can be incorporated.

We characterized design as inherently iterative, that is, iterative beyond the prescriptive sense of "design one to throw away." New purposes, new requirements emerge from a design as soon as it is embodied, and continue to emerge as people (i.e., users) appropriate and adapt the design within their own activities. One way this was put was to say that software "changes the world." Another way was to say that new artifacts change people's expectations and values.

Another way this was described was using the task–artifact cycle: the notion that a design (artifact) responds to activities (tasks) in the world, directly transforming them in some ameliorative manner (i.e., achieving requirements), but also, most likely, introducing other transformations (creating new unanticipated affordances, and perhaps unfortunate side-effects).

We characterized creativity in design as playfulness, pursuing surprise, and unexpected outcomes. Another aspect of creativity in design is empathy: The exercise of putting oneself

into the role of another. Another is liminality: Thinking and acting on the border between two contrasting concepts or rules, such as a rapid switching between convergent and divergent modes of thinking.

We characterized rationale in a variety of ways. One was to consider it a design representation: a way of presenting a design that contrasts with other ways (e.g., sketching, software prototypes), and resultingly evokes descriptive tensions (and perhaps creativity).

Rationale can be prospective (i.e., generated within design activity, as an enabling part of design work) or retrospective (i.e., generated after design activity, perhaps even after the design is embodied and in use). This distinction is important because retrospective design rationale can only evoke creativity for subsequent design work. And conversely, one cannot get the retrospective benefit of perspective and reflection just by "capturing" prospective rationale in situ.

We also characterized the role of rationale in design in a variety of ways. Most basically, rationale is a kind of documentation. This is actually a complex and problematic concept. For example, it is clear that there are many possible rationales for any feature, for any decision taken. Which rationale is to be codified? Rationale could be documented at many levels of detail: Should it be relatively sketchy, focusing on key ideas and issues, or should it be highly detailed?

Thinking of rationale as documentation also raises division-of-labor questions such as whose job is it to capture the rationale, whose job is it to validate the rationale, whose job is it use rationale created by someone else. These cost–benefit tradeoff questions arise whenever a workflow involves people extrinsically tasked to create value for others in an organization.

Rationale as documentation might of course limit creativity (see above) by anchoring thought, and limiting divergence or risk taking. But it could also evoke creativity by framing the design world in terms of the issues and choices that are being managed, and perhaps doing this in multiple ways. In other words, codifying the disciplined part of the designer's world might make it easier to problematize the parts of the world that are codified, by labeling them, but it could also make it easier to problematize the parts that are not yet codified, by contrasting them against the provisional frame.

But there are other ways to see rationale. For example, the discussions among stakeholders presenting, analyzing, and perhaps contesting, assumptions, decisions, values, roles, processes, and so on are also rationale. This is Rittel's (Kunz & Rittel, 1970) democratic conception of many authors contributing to making an argument space more visible for all.

Indeed, focusing on design as a potentially—and perhaps even typically—collaborative task changes the way one might characterize the activity of creating and using rationale. After all, collaborators must continuingly create common ground. This is never a matter of once and done. As the shared activity develops, as assumptions and commitments are made as interim outcomes are obtained, collaborators must make these things public at least to the extent required to allow effective coordination of individual contributions.

For example, Minneman (1991) reported that part of design collaboration is reaching agreement about issues that will not be discussed again (at least for some span of time). This is a highly specialized area of common ground management, and one that design rationale could support, just by providing a language to cordon off areas of discussion and debate.

Like most workshops, this one ended up posing, but leaving open, many questions and identifying projects that ought to be undertaken, but have not yet been started. For example, if rationale can support creativity in design through reframing, that is, through helping designers

designers see their design world in alternative ways, what specific properties of rationales can facilitate this function, what are the rules and heuristics of rationales that provoke insights? One future project we articulated was identifying cases where rationale evoked ideas that had not been raised before in a given design process. What are kinds of ideas are they? What kinds of rationale evoked them? What were the design process circumstances in which they were evoked?

THIS SPECIAL ISSUE

A key objective of the workshop was to facilitate longer term processes of scholarly interaction, and the development of more refined proposals, analyses, and results. One result, then, is this special issue of *Human Technology: An Interdisciplinary Journal on Humans in ICT Environments*, which presents six papers developed from presentations and discussions at the Creativity and Rationale in Software Design workshop.

The first two papers examine roles that codifications of design ideas and interactions can play in evoking creativity. In "Critical Conversations: Feedback as a Stimulus to Creativity in Software Design," Raymond McCall analyzes critical conversations among designers and other stakeholders as integrating ideation and evaluation, through both reflection and situated cognitive analysis, to provide feedback about consequences of design decisions that challenges designers to devise new ideas. McCall argues that exploiting the full potential of critical conversations requires rationale methods that are better integrated with software tools. The second paper, by Alistair Sutcliffe, "Juxtaposing Design Representations for Creativity," argues that the concurrent use of scenarios, prototypes and models can evoke creativity by juxtaposing complementary cognitive affordances.

The next two papers address design as collaborative work. In "Promoting Group Creativity in Upstream Requirements Engineering," Rosalie Ocker examines this topic by focusing on negative intergroup social processes associated with status differentials, in-group bias, and majority influence, which are known to undermine group creativity. She shows how creativity can be promoted by group support system tools that incorporate design rationale. Albert M. Selvin, Simon J. Buckingham Shum, and Mark Aakhus, in the fourth paper, "The Practice Level in Participatory Design Rationale: Studying Practitioner Moves and Choices," present a theory of practice, and analytical tools, to identify some of the creative dimensions in expert practice when constructing design rationale visualizations in meetings.

The final two papers examined the role of rationale in the development of design professionals. Janet E. Burge and Bo Brinkman, in "Using Rationale to Assist Student Cognitive and Intellectual Development," address the challenge students experience when they first encounter problems for which there is more than one "right" answer. They found that introducing students to design rationale techniques helped them consider multiple alternatives and to reflect on reasons for choosing a particular alternative. Finally, in "Does Design Rationale Enhance Creativity?" Jing Wang, Umer Farooq and John M. Carroll studied the design processes and outcomes of student teams in an advanced software engineering course. They found that greater use of design rationale by teams was correlated with more creative outcomes. In particular, they found that the comprehensiveness of tradeoff analysis and the feasibility of design alternatives in the rationales were critical to enhancing novelty, persuasiveness, and insightfulness of the designs.

Thomas Kuhn (1962) wrote that "Like artists, creative scientists must occasionally be able to live in a world out of joint" (p. 79). He called this the essential tension: Research always produces anomalies between theoretical concepts and empirical data; the possibility of crisis and breakdown is always present. A routine problem from one perspective can be a crippling counterexample from another. Faced with significant crisis, scientific communities may engage in what Kuhn calls extraordinary science, in which fundamental assumptions are questioned, conventions are abandoned, and innovative practices become routine.

Describing, developing, and fully enjoying the linkages between creativity and rationale in software design will entrain essential tension. Perhaps we are now at the threshold of a period extraordinary science. Indeed, Kuhn's notion seems appropriate for what has recently been called "a science of design" for software-intensive systems (Freeman & Hart, 2004). Surely, a science of design would have to be extraordinary; it would have to question assumptions, innovate, reorient and recreate itself. The tensions between relatively discursive, qualitative, and conceptual social-behavioral art and science, and relatively formal, quantitative, and device-oriented computer science and software engineering are inherent and abiding. We must recruit it as an intellectual resource and not (only) experience it as a source of interdisciplinary conflict. Further and finally, I think people are indeed attracted to software design in part because it is exciting to live in a world out of joint, and to participate in a perpetually extraordinary endeavour.

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