Ideas, subjects, and cycles as lenses for understanding the software design process

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In this paper, we provide an analysis of three pairs of professional software designers, each working on a provided design problem. To understand these sessions, we track the ideas that were generated, relate them to one another, and categorize them according to the subject being discussed. This data is then used to divide the sessions into design cycles, each of which represents a period of focus on a given aspect of the system being designed. We observe that the designers often consider two subjects at a time, and rotate through subjects in an effort to develop them evenly. The sessions are also characterized by a great deal of repetition, as the designers regularly reconsider previously stated ideas in new contexts.

Keywords: software design, design process, design ideas

As designers work to understand a problem and how to solve it, they generate a large number of ideas. As the design process progresses, such ideas are weighed, compared to one another, and some notion of good and bad ideas is developed. Eventually some ideas are used to compose a final design (Jones, 1970). We are interested in understanding how this progression takes place in software design. What strategies and patterns govern the kind of ideas that designers generate, how are those ideas evaluated, and what process is used to arrive at the set of accepted ideas?

To build up our understanding how designers address *software* design problems, we have studied the sessions recorded for the Studying Professional Software Designers 2010 workshop. This workshop was based on video recordings of three pairs of professional software designers, each of which was asked to solve the same provided design problem. The designers were given an hour and fifty minutes to design the basic code structure and user interface for a traffic simulation program, and were provided with a whiteboard and pens, but no other tools. A more complete description of the design task being studied can be found in the introduction to this journal issue.

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As a first step, we analyzed the three videos and tracked the individual *ideas* that the designers generated over the course of each session, recording the

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places when ideas built upon one another. Then, in order to gain a higher-level understanding of these sessions, we categorized the ideas that the designers generated according to their *subject*, and we divided the sessions into clusters of ideas called *cycles*.

With these notions in hand, we observe that the sessions were characterized by the repeated discussion and recontextualization of a set of core ideas and subjects. Specifically, as the designs evolved, previously stated ideas were frequently restated and reconsidered. On a higher level, the designers tended to consider two subjects at a time, and over the course of the sessions they considered the same small number of subjects many times, in different pairings. The result was a process that had characteristics of breadth-first design and incremental design, but that delved into details differently; we found that there was a focus on finding key, organizing ideas and adjusting them to work relative to one another to create a cohesive whole.

This work follows in the tradition of studies, such as Ennis and Gyeszly (1991) and Goldschmidt (1990), who looked closely at the problem-solving process used by designers in non-software design fields, and also builds on and expands on the comparatively small number of studies of software designers in action, such as Guindon (1990) and Zannier, Chiasson, and Maurer (2007). Its primary contributions are its description of the designers' two-subject discussions, and its explanation of the design process as containing frequent repetition and recontextualization of ideas.

1 Approach

In order to understand the *ideas* that the designers generated, it was necessary to develop two higher-level concepts to use in organizing and categorizing them. Firstly, we observe that each of the six designers structured their thinking about the design problem in terms of a number of distinct *subjects* of discussion. This concept of subjects provides us with a way to categorize the designers' ideas by their content. Secondly, the designers' progress was not steady; they set out to discuss a given aspect of the problem, made progress, and then when that progress dwindled, they picked up a new aspect of the problem to focus on. We describe each such sequence as a design *cycle*, and this concept provides us with a way to categorize the ideas according to their temporal location in the design process. In this section, we will described these notions of ideas, subjects, and design cycles, as well as the techniques we used to define and analyze them in the sessions.

1.1 Ideas

The initial step in analyzing the corpus was to move through the sessions and record each occasion where an idea was generated. An idea, in this case, refers to a statement by one of the designers that: a) characterized the provided problem; or b) provided some suggestion for how to solve part of the problem. For