A Framework for Reflective Practice in Innovative Design*

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It is a primary goal for designers to create not just high quality designs, but new and innovative designs. The means to promote creative ideation on a consistent basis, and the conditions under which designers create new ideas are not well understood. In this paper we discuss preliminary research on reflective practices used by designers in idea generation. We present a variety of reflective practices used by design students in coming up with new insights and ideas. We offer a clarified definition of reflective practice, derived from Donald Schön's concept of reflection-in-action and prior studies of our own. Lastly, we propose and assess a framework for characterizing reflective practices.

Keywords: reflection; reflective practice; design; reflection-in-action; reflection-out-of-action

1. Introduction

The 'fuzzy front-end of innovation' offers the context for laying out the foundation for innovative design through new concept creation [1], yet this front-end is poorly understood and therefore offers significant opportunity for improving the innovation process. [2–5] show Design Thinking to be a successful approach in encouraging new concept generation early in the design process. In combination with project-based learning, some general Design Thinking practices have also found their way into the classrooms or lofts [6].

However, the practical means to promote increased creative ideation remain elusive and poorly understood both in practice and in education, and research has offered little in the way of impacting this. The move toward project-based learning and problem-based learning in engineering education presents an appropriate and timely opportunity to understand, transfer and incorporate reflective practice from design practice into engineering education.

The starting point for our research is a situation known to all engineers and designers: when getting stuck on a certain problem, it is sometimes best to lay it aside and engage, maybe purposely, in a completely unrelated activity, such as taking a walk or showering. Quite often, these activities, which we will call reflective practices, suddenly generate new insights or open up new solution pathways. This phenomenon of reflective practice is at the center of our research. Our general guiding questions are:

1. What role does reflective practice play in Design Thinking?
2. How can designers learn to use reflective practices purposefully to maximize the potential for creative ideation?

3. How can reflective practices be integrated into engineering education?

1.1 On the relevance of reflection in design

There are two main paradigms within which researchers characterize and study the design process—that of design as rational problem solving, and that of design as a reflective practice—exemplified by Simon and Schön respectively. Simon's positivist perspective on design remains the predominant one in design methodology research and in design education. Our understanding of design draws from the perspective of Schön and our current research is built upon his constructivist approach [7].

Schön's description of the reflective practice of design is focused on 'reflection-in-action', or explicit reflection that happens in the context of the design task at hand. This concept of reflection-in-action is only very loosely bounded by the 'action present', a term that encompasses the 'time in which action can still make a difference to the situation. The action-present may stretch over minutes, hours, days, or even weeks and months, depending on pace of the activity and the situational boundaries that are characteristic of the practice' [8].

Recent research, however, indicates a distinction between design-productive reflection within and outside of the context of explicit design activity [9]. In these studies we introduced the term 'reflection-out-of-action', documenting it as a practice utilized by designers in coming up with new ideas [9]. Reflection-out-of-action still occurs within Schön's action-present, but with characteristics distinct from explicit reflective practice that occurs directly in the context of design activity.

1.2 Integrating reflection in engineering education

The distinction between the two paradigms of design as rational problem solving and design as

reflective practice becomes increasingly important to engineering education as researchers propose initiatives such as CDIO. The proposed Conceiving—Designing—Implementing—Operating process aims to bring engineering education back to its roots, situating it in the more practical context of real-world design challenges, and replacing the old knowledge-based context of memorizing, calculating, and solving pre-defined theoretical problems [10].

Significant research investment has been made in recent years in the enhancement of engineering education [11]. Integrating design in Engineering programs has become standard practice as well as a requirement of the ABET accreditation of engineering schools [12]. Design education, however, often remains situated in programs, which espouse the view of design as rational problem solving, and therefore, establish these new design initiatives with an overly methods-based focus. Design programs present students with an array of tools, techniques, and processes to solve design problems, but often these are presented as mathematical formulae or black box systems. They are sometimes expected to use tools or practices, such as idealogging and mindmapping, which are reflective in nature, but with no knowledge of why they work, and without adequate emphasis on using them in a reflective way. Students are expected to reflect, but they are not taught how to do so.

What is typically missing is both an awareness of the limitations of design methods and processes, and an understanding of how to teach reflective practices as aids for design thinking. Some researchers have begun to explore the benefits of specific (isolated) reflective practices for learning [13] or for idea generation [14, 15]. There remains, however, a lack of research aimed at understanding reflective practice more broadly and characterizing dimensions of reflective practice through examination of a variety of commonly used reflective practices.

2. Previous work

Our prior studies have employed qualitative research practices, examining and characterizing reflection in design through conceptual framing exercises, artifactual evidence (idealogs), and survey accounts of expert designers' perceptions of their reflective practices [9]. The idealog-based study pointed toward a variety of kinds of reflection in design and indicated that they are characterized by how much they draw upon memory vs. external stimuli. The survey study revealed the significance of reflection that happens outside of the context of focused, intentional design work, and led to the distinction between reflection-in-action and the new notion of reflection-out-of-action.

These led to the development of a framework for mapping reflective practice, based on two dimensions (remembering/gathering and in-action/out-of-action) (Fig. 1).
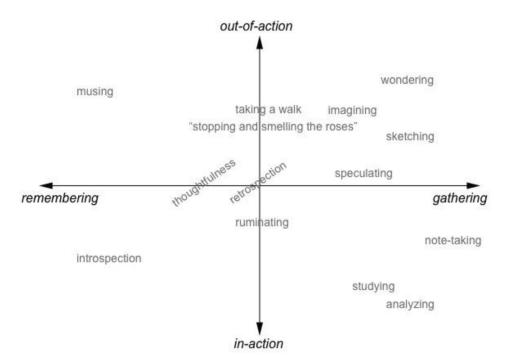

Fig. 1. General conceptual framework for reflection, showing two dimensions for characterizing reflective practice: (1) x-axis: remembering vs. gathering; and (2) y-axis: in-action vs. out-of-action, populated by researchers' examples [9].

3. Goals and methodology

The current study is also qualitative in nature, and further investigates the topic of reflective practice through semi-structured interviews.

The goals of this study are to evaluate the framework from the previous studies in an educational context. We aim to collect a range of reflective practices used by designers (in this case, novice and intermediate designers) and see how they map to the framework proposed in our prior studies, and to ultimately characterize the relationship between specific reflective practices and other variables such as: the individual designer, the problem of interest, type of ideas resulting, or the design context.

We solicited participation from Stanford undergraduates in Mechanical Engineering and Product Design, who had completed the ME101 design course, and graduate students in the Stanford Joint Program in Design. We interviewed three graduate students and four undergraduates (two each from Mechanical Engineering and Product Design).

We introduced to them the notion of reflective practice, describing it as 'an activity that you engage in, which helps you think through design situations and leads you to new insights or ideas. Some examples might be: sketching going for a walk, making a mindmap, doing analogies, baking.' We then asked participants to tell us about and sketch or write out the process that they used in a current or recent design project. After this we invited them to refer back to their now-visually represented process and to tell us where reflective practice occurred, either within the process, on the side, or behind the scenes, and repeated the description of reflective practice.

Most interviews lasted between 25 and 30 minutes. Graduate students were interviewed first. After this first round, we recognized the value in directly soliciting the participants' opinions of where their practices fit within our framework, rather than simply assessing this ourselves. So in the next round of interviews we asked the (undergraduate) participants to indicate where they would map their reflective practices on our proposed framework. Three of the four undergraduate participants completed this exercise.

4. Findings

The analysis of the interview data unearthed some key reflective practices:

'Mindless' activities: We were intrigued to find that two graduate participants specifically mentioned mindless activity as a basis for reflective practice.

The third echoed this notion with the statement that 'you need to not be doing anything too mentally taxing' and described napping as her primary reflective practice, saying 'I'm actually a huge napper—all of my good ideas come when I'm napping' and 'I'm one of those people who, when I'm kind of in that like half-asleep but not quite asleep state, is when I get all of my good thinking done.' One undergrad participant said, 'I don't have to focus on anything except what I have to think about and if I want to think about nothing that's possible too.'

Physical activities: All three grad students and one undergrad cited exercise (going to the gym, running, biking) as a reflective practice, and the remaining undergraduates all included the physical activity of walking among their reflective practices. For example, one student said 'sometimes ideas just sort of creep into my mind when I'm in the rhythm of running.'

Conversation: Talking to friends, in person or over the phone was another commonly mentioned reflective practice. One undergrad described talking with her friend while driving and bouncing random ideas off each other. Another mentioned frequently talking to his housemates and getting ideas from their conversations. Still another described two different kinds of conversation as reflective practices— 'group thinking conversations' with his project teammates and dinner conversations with others.

Remembering: One graduate student and one undergraduate especially emphasized remembering ideas. The first noted that his doodles (one of his primary reflective practices) all hold for him strong connections to the memory of whatever he was listening to at the time. The second said, 'I'll have these great ideas and I'll never write them down, so it's just forgotten.' Still another grad student referenced memory less directly, saying that while biking 'stuff just kind of like filters through and you kind of rethink through conversations you've had and different things will pop out, like 'what did they mean when they said that' or 'maybe you could put those other two ideas together and something cool would come from it.''

Sketching: On graduate student indicated doodling as a reflective practice and said that he doodles a lot. Other students generally noted a value in sketching while talking about their reflective practices, but said either that they didn't do it enough or that they struggle with sketching and can't sketch fluidly enough.

4.1 Assessing the reflective practice framework

Of the three participants who mapped their reflective practices onto our framework, two populated

all four quadrants with at least one reflective practice, and the third populated three of the four quadrants. When overlaid on the same graph we can see a broad distribution of reflective practices and roughly equal representation in all four quadrants (Fig. 2). This distribution, resulting from participants' mapping of pre-described practices in the framework indicates the appropriateness of the dimensions in characterizing reflective practice. This is further supported by the fact that participants, while sometimes hesitating or confused at first, in identifying or naming their reflective practices, were able to map them onto the framework with relative ease.

We did not find any inconsistencies or surprises in how participants mapped reflective practices on the y-axis (in-action/out-of-action) but we did note that different participants mapped walking and brainstorming on opposite sides of the remembering/gathering axis. This does not necessarily denote a flaw in our framework, as different individuals may approach the same general practice with a different focus, one focusing more on remembering and one more on gathering. It might, however, point to confusion or discrepancy in their understanding of the meaning of the dimensions represented in the framework. We were surprised to find mindmapping mapped so far to the right (indicating a strong gathering component and a weak remembering component). But we do recognize both components at play in this reflective practice, as the designer maps what is already in his mind (memory component) but also may see things differently once they are on the paper and map new things that come from seeing his thoughts on paper (gathering).

Also notable, is the higher number of practices mapped to the peripheries than to the middle section of the framework. A possible explanation might be that the design students purposely, or simply by experience, engage in practices that combine the two proposed dimensions in order to profit from reflective practices.

5. Conclusion and next steps

We were able to accomplish two of the goals we set out to achieve—to assess the appropriateness of our conceptual framework and to collect and map onto this framework a range of reflective practices used by designers. Further studies will have to be done before we can to meet the goal of characterizing the relationship between specific reflective practices and other variables such as individual personality, field of study, or level of expertise, or task-related variables such as topic or subject matter.

The interviews yielded a rich set of data about the reflective practices of novice (undergraduate) and intermediate (graduate) designers. They offered detailed descriptions of their design processes, opinions about and deviations from the design processes and methods that they are taught to use, their thoughts on reflective practice in general and on what features or characteristics set the stage for good reflective practice, their design philosophies, and more. We only touched upon a subset of the possible lenses through which we might look at the data gathered in this study. One lens, which we did not use but which may offer interesting insight, is the lens of major field of study. We would like to explore this further, and to look for distinctions in how mechanical engineers and product designers might talk about process, design, and reflective practice.
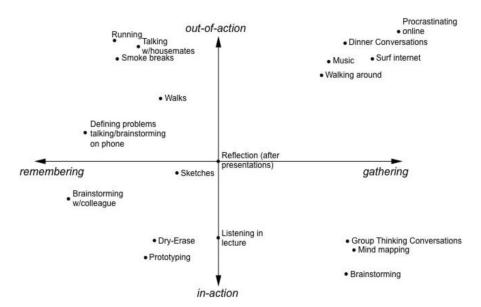

Fig. 2. Conceptual framework for reflection, populated by interview participants' reflective practices.

We also think there may be, in one or both majors, effects on these things due to level of experience and education. We will begin to examine these by interviewing two or three additional students who are graduates in mechanical engineering.

We are aware that our study is a preliminary explorative study, and is small in sample size, both of which factors limit the strength and generalizability of our findings. The interviews, however, did yield a rich set of data from which we have drawn a wider array of insights than we originally anticipated, and which has informed our next steps.

The next stage in our research will include expanding our survey- and interview-base, taking data from a larger sample of designers with a broader range of experience (including industry practitioners, and professors of design). Additionally, we plan to survey the broader population beyond just designers, to see if and how designers differ from non-designers in their choice and use of reflective practices to come up with ideas and insights.

Of course, as the overall aim is to support creative ideation, it would certainly help to be able to evaluate the quality of ideas generated and to correlate reflective practices with quality of ides. This, however, remains elusive in that new ideas, in the fuzzy front end of design, are not fully developed, much less tested, and therefore cannot be accurately or completely evaluated in their early form. At this point, we hope to encourage educators and students to also engage in reflective practices in a conscious way. Our four-quadrant framework may provide a first guideline in testing different practices. We hope to further enhance our understanding of the role of reflection in creative ideation through observing and listening to designers' more detailed accounts of their reflective practices. Ultimately, we aim to create a model, which relates different reflective practices to different individuals and to different design tasks.

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