Storyboarding: An Empirical Determination of Best Practices and Effective Guidelines

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ABSTRACT
Storyboarding is a common technique in HCI and design for demonstrating system interfaces and contexts of use. Despite its recognized benefits, novice designers still encounter challenges in the creation of storyboards. Furthermore, as computing becomes increasingly integrated into the environment, blurring the distinction between the system and its surrounding context, it is imperative to depict context explicitly in storyboards. In this paper, we present two formative studies designed to uncover the important elements of storyboards. These elements include the use of text, inclusion of people, level of detail, number of panels, and representation of the passage of time. We further present an empirical study to assess the effects of these elements on the understanding and enjoyment of storyboard consumers. Finally, we demonstrate how these guidelines were successfully used in an undergraduate HCI class.

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Storyboarding, user centered design, HCI education

ACM Classification Keywords
H5.2 [Information Interfaces and Presentation]: User Interfaces- Theory and methods, User-centered design.

INTRODUCTION
The practice of creating storyboards has a long history, particularly in communities such as those for developing film, television segments and animations [6]. However, there is a lack of literature on research of this practice within the areas of HCI and design. As a result, novice designers often lack tacit knowledge about storyboarding that expert designers find obvious after much practice and experience. Furthermore, although storyboarding is an effective, low-fidelity prototyping technique, novice and professional designers alike face challenges in creating storyboards for new innovative applications. As interactive computing moves off the desktop, storyboards must demonstrate not only the details of a specific interface but also higher level concepts surrounding user motivation and emotion during system use. Users increasingly need to see and understand the context, including the environment of use, physical embodiment of a system, and user interactions with and reactions to system elements. Thus, storyboards must depict not only a user's interaction with ubiquitous computing technology but these other factors as well.

In this paper, we highlight the stages in successful storyboard generation. We reveal the design elements common to storyboards created and used by novice and professional designers and HCI specialists. We note differences between the practices of the novice designers and the professionals. We then discuss how the uncovered design elements impact the understandability of a storyboard from the perspective of a potential end-user, for both familiar and novel applications. We describe the expert practices of professional designers for creating storyboards and relate those to the processes and challenges reported by novices. Finally, we present generalized guidelines that designers may use as a first step in creating storyboards and report on our initial experience applying these guidelines in an introductory HCI project class.

BACKGROUND & RELATED WORK
A storyboard is a short graphical depiction of a narrative. Storyboards can be used for a variety of activities. In designing new technologies, storyboards often illustrate an envisioned scenario of how an application feature works. Rosson and Carroll described four kinds of scenarios that designers can use in the development of a software application [11]. During the analysis phase of software development, designers study the current practices of stakeholders and perform field studies to generate problem scenarios. During the design phase, designers use activity scenarios to introduce concrete ideas about how the user's requirements can be met through high-level functionalities introduced by a new system that will inherently affect the user's current activities. Then designers create information design scenarios, which specify representations of a task's objects and actions that will help users perceive, interpret and make sense of the proposed functionalities. Finally,

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interaction design scenarios specify how users would interact with the system to perform the new activities.

The use of scenario-based design methods can be beneficial in two specific ways [11]. First, use case descriptions are important in discussing and understanding how technology reshapes human activity. Second, these scenarios can be created before the system is built and its impacts are felt. Likewise, the use of storyboards provides similar benefits. Furthermore, the specific wording in text-based scenarios can influence the understanding of and reaction to a system. Thus, designers often use storyboards rather than scenarios as a less biased visual depiction of the same information.

Existing research storyboarding tools such as Silk [8], DENIM [9], and DEMAIS [3] support interaction scenarios, conveying to users how to interact with the envisioned system. For example, Silk allows designers to sketch user interfaces easily; the system recognizes the designer's ink strokes and can be placed into simulation mode to allow the user to experience the envisioned interaction. These tools enable designers to visually convey the envisioned interaction for a specific class of applications. Such storyboards act as low-fidelity versions of the application, which designers can use to study the usability of the interface. These storyboards do not require the embodiment of the larger context of use that can be critical in the design of off-the-desktop applications.

Commercial products marketed specifically for storyboard creation [2, 14, 15] are available, but they are designed for experts and can be difficult for novices to use. These difficulties arise from the inherent complexity of the tools and their multimedia focus, both of which were reported to be confusing. Also, expert designers expressed that the greatest challenge for them is storytelling. These software products are not designed to support that process and may even be detrimental to it, because they do not provide complete creative flexibility in terms of what can be developed. Thus, most designers have co-opted other products intended for different purposes. A more detailed discussion of these products is presented later in this paper.

METHOD

We conducted three studies to determine a structured set of guidelines for creating storyboards. First, we gathered and analyzed storyboards created by students in graduate and undergraduate HCI classes and by expert designers and professional storyboard artists to determine the key features often included in storyboards, analyzed through an established framework for visual storytelling [10]. We also interviewed individuals from these two groups to understand the processes used and challenges encountered in developing these artifacts. Finally, we conducted a controlled study in which we systematically varied different features to understand their effects on understandability and enjoyment of the storyboards by storyboard consumers. The features to vary were selected based on the existing literature on visual storytelling and on the findings from the artifact analysis.

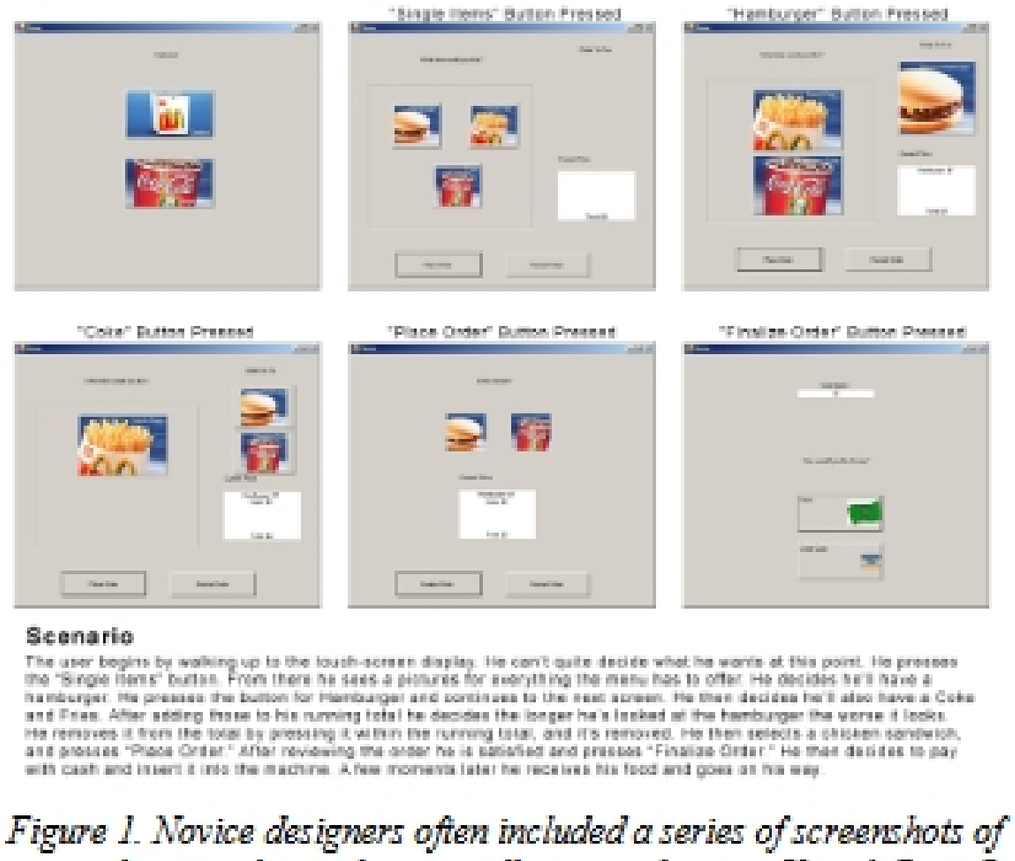

Figure 1. Novice designers often included a series of screenshots of a non-functional interface rapidly created using Visual Basic® with a long textual description of the envisioned scenario. The particular details of this example are not significant, but it illustrates this trend.

Artifact Analysis

We reviewed project artifacts created from 32 teams from different offerings of an introductory HCI class taught at our university over the previous four years. From this group, we gathered storyboards from the sixteen projects that produced them. Although most instructors of this course encouraged students to design off-the-desktop applications, some teams developed storyboards for desktop applications.

Additionally, we gathered 26 storyboards created by expert designers and HCI professionals. These artifacts included those from product design teams for major companies as well as those created by expert designers from industrial and academic research labs. All of these storyboards depicted concepts for novel technologies in the early design phases of product development at their companies.

Through this artifact evaluation, we were able to uncover the salient features of storyboarding. Two researchers examined each artifact, measuring it along twelve recognized dimensions taken from an analysis for visual storytelling [10]. The individual evaluations were then discussed among a team of three researchers to reconcile any points of difference. Finally, during these discussions, the novice artifacts were compared as a group with the expert artifacts, considering these dimensions and the stories being portrayed. This comparison highlighted ways in which novice storyboards can be improved, particularly as we explored the allied processes used to create them.

Semi-Structured Interviews with Novice & Expert Designers

Participants in the interviews included eight novice and five expert designers who had experience with creating storyboards. Interviews lasted one hour and were conducted at places of the participants' choosing. The novice designers

that we interviewed were members of different project teams from introductory HCI classes from whom we had previously gathered storyboards. Three of the expert designers work for a large technology company; one a user interface designer, the second an interaction designer, and the third an information architect. The fourth expert participant is an industrial designer for a large software security company. The final expert participant is a multimedia designer for a small graphics company. The interviews focused on the creation process and the challenges typically encountered in that process.

Survey of Storyboard Consumers

Over a four-week period, 97 participants responded to a multi-part survey in which they were shown four pairs of storyboards created by the researchers for the study. Each pair told a similar or the same story but with one design element varied. These design elements were uncovered during the artifact analysis and interviews and will be discussed in more detail in the Results section but are summarized as follows:

- Inclusion of text in the form of captions, labels, or speech/thought bubbles,
- Length of the storyboard in terms of number of individual frames,
- Level of detail - classified along a spectrum from low (stick figures with little background) to photo-realistic (with detailed background images),
- Explicitness of time passing (*e.g.*, through use of a clock), and
- Inclusion (or exclusion) of human actors.

The four pairs shown were randomly selected from a potential twenty pairs that included ten systems currently in everyday use and ten ubiquitous computing applications intended for everyday use. We held four of the five elements constant for each pair and varied the fifth, with each variable being tested on two pairs of familiar and two pairs of novel application storyboards. Survey participants responded with their interpretations of the story represented in each storyboard. A time limit was placed on this question in an effort to ensure that the respondent indicated only initial impressions of the storyboard. Additionally, the survey asked participants to rate the difficulty of each storyboard and indicate which factors did or would help or hinder their understanding. After both storyboards in a pair were presented and questions about each answered, the respondents then described differences perceived between the two versions of the story. These responses were coded independently by two researchers for perceptions of understandability, aesthetic quality, and entertainment. Of the 97 respondents, 68 answered questions for all four pairs and 85 answered all questions for at least one application.

RESULTS

In this section, we present the results of the three studies. We present the processes garnered from both novices and experts involved with storyboard creation. We then present the five attributes that comprise storyboards and the range of values for those attributes that could be present. Finally, we discuss how the values of these attributes coupled with the story and interfaces being represented affect both the process of storyboard creation and the understandability and enjoyment of the storyboard by readers.

Storyboarding Process

Throughout our interviews with novice and expert designers, participants reported beginning with a similar storyboarding process. Designers typically brainstorm individually about design alternatives, capturing their ideas in quick sketches using pencil and paper. Next, the designers meet as a group to discuss their ideas. Experts regularly meet in front of a shared visual work surface, usually a whiteboard. This wall can then act as both a timeline and a source of inspiration throughout the creation process. The students we interviewed tend instead to meet in a common study area. During this meeting, designers compare and contrast their visions of the storyboard. By discussing their ideas and reviewing early artifacts, the team can develop a shared understanding of the application and greater context of use for a given design. At this stage, the storyboarding process begins to differ greatly between the novice and expert designers, with novices tending to work closely together and experts separately, returning periodically for critique sessions with the group and then iterating alone.

The biggest challenges reported by the student designers we interviewed include 1) not knowing what to start drawing and

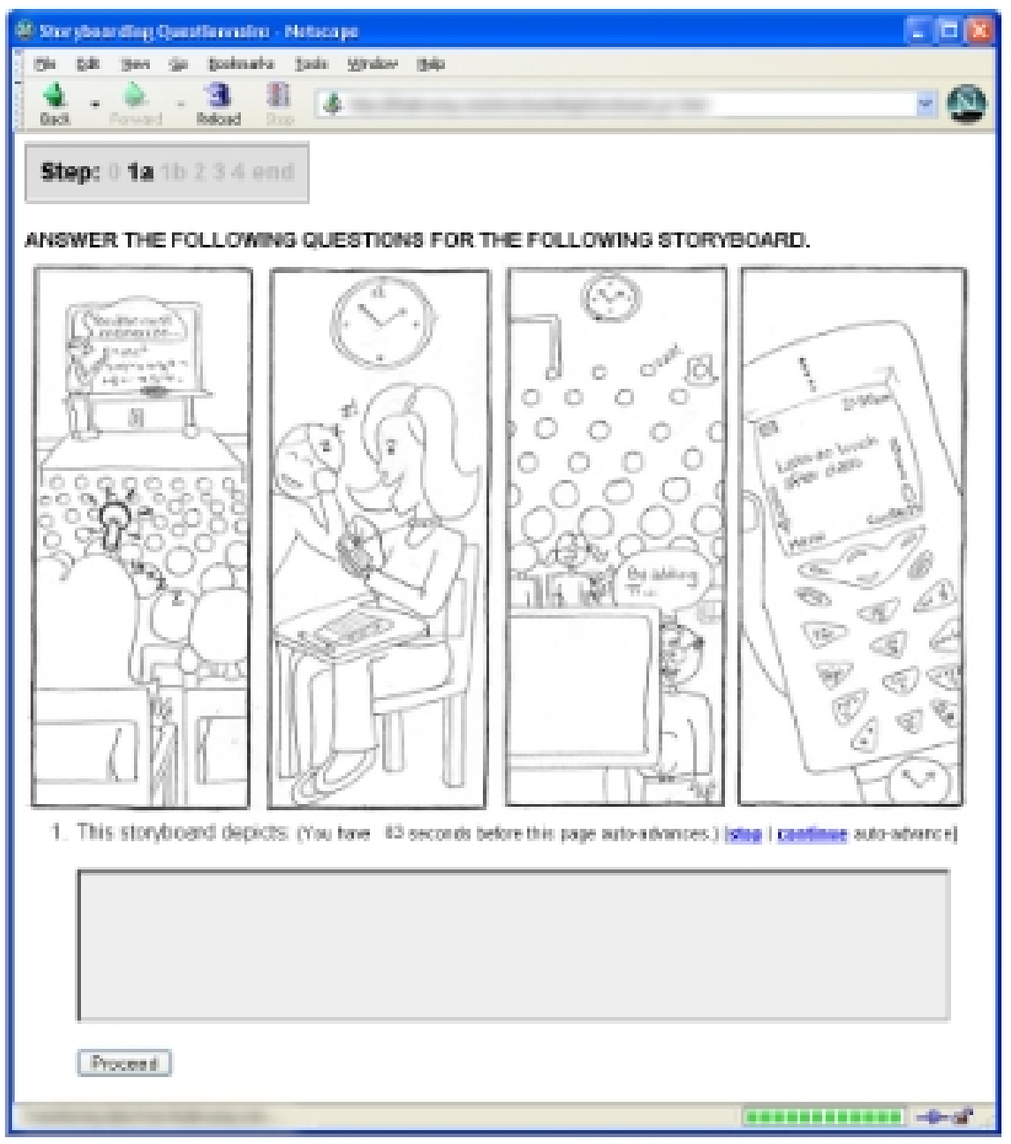

Figure 2. Web-based survey to study user requirements in understanding storyboards.