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

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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.

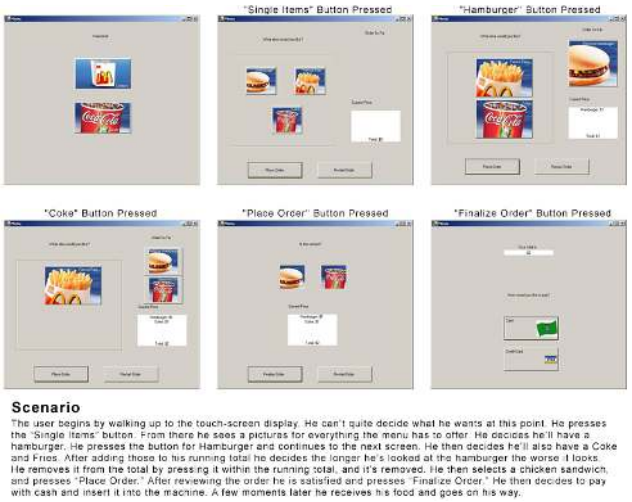

Figure 1. Novice designers often included a series of screenshots of a non-functional interface rapidly created using Visual Basic® with a long textual description of the envisioned scenario. The particular details of this example are not significant, but it illustrates this trend.

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

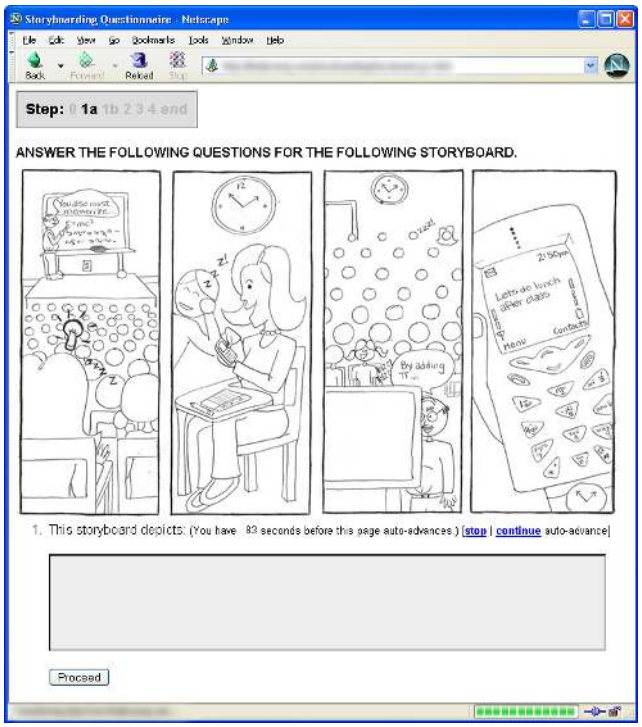

Figure 2. *Web-based survey to study user requirements in understanding storyboards.*

2) not being "skilled" in drawing. Working co-located was one solution repeatedly mentioned for addressing these hurdles. These work sessions lasted between one and eight hours with the groups we interviewed. Co-location allowed the design teams easily to share artifacts within the group for quick feedback. As a result, they often iterated directly upon their artifacts rather than creating discrete versions of the storyboard. A second advantage to their choice to work closely together was the ability to borrow directly from each other's artifacts through tracing or digital copies. Reusing successful artifacts was reported to be a significant advantage by all the interview participants primarily because participants did not view themselves as having artistic skill.

All of the novices we interviewed created many more sketches than they ultimately used. Novice design teams reported generating at least two to three times the number of sketches needed. Individual designers generated a collection of sketches for an envisioned interaction, often trying to create the same story using several different approaches. Once completed, the team together would narrow the collection of sketches and piece them together to form a storyboard. In those situations in which holes still existed in the story, someone from the design team would draw a new panel to fill that hole. The students reported needing to create so many extra sketches, because they were unable to envision how the story should flow without the visual artifacts in front of them.

In contrast to the novice's process, experts reported typically using the initial meeting after their individual quick sketches to help them better understand the overarching message the storyboard(s) should deliver. The biggest difficulties encountered by expert designers lie in determining the overall story. Like the novices, they spent a large amount of time determining how to tell the story in small succinct parts. Unlike the novices, however, they reported using brief sentences for this portion of the story; the novices reported using previously created sketches. Hence, the experts did not report creating nearly the mass of extra sketches reported by the novices. After the critique sessions, individual artists iterate on the work, and then return to the wall to share again.

Expert designers reported creating electronic artifacts after some level of comfort was reached with both the story and the initial paper-based sketches. They commented that Adobe® Photoshop®, Adobe® Illustrator®, and Microsoft® PowerPoint are the applications of choice. Also mentioned were a variety of other products including Macromedia Director and Flash. The focus both of this paper and of the interviews was understanding still presentations as opposed to dynamic, interactive storytelling. This focus explains the emphasis of this paper on guidelines for these types of storyboards, and may also explain the emphasis by the participants on these types of technologies.

All of the expert participants mentioned extensively using the layering features that Adobe® Photoshop®, Adobe® Illustrator®, and Microsoft® PowerPoint provided, because these features allowed them to save and add different versions of their storyboards easily. One expert noted that he used PowerPoint because it was easy to insert, delete, place, and resize simple shapes and text. The one drawback to using these tools, however, is that the designers still needed to rely on other sources for generating images for inclusion in the storyboard. Some experts used stock photos from websites such as istockphoto.com, then added filters and otherwise modified them to create a consistent feel throughout their storyboards. If an adequate stock photo can not be found on the Internet, experts reported creating images from scratch and modifying them to fill in the gaps in the story while maintaining consistent visual appeal.

Overview of the Elements of a Storyboard

Using storyboards developed both by professionals and by amateurs, we determined five significant attributes of storyboards:

1. **Level of detail.** The level of detail present in a storyboard must take into account how many objects and actors might be present in a particular frame, the level of photo-realism incorporated by the designer, and the designer's choice to display the entire scene or only details of the interface.
2. **Inclusion of text.** Designers can include text either through tagline narrations for each pane or within individual frames as speech, thought bubbles, or labels and signs that would be present in the real life environment depicted in the storyboard. Alternately, designers can choose to depict the story entirely using visual elements with no text.
3. **Inclusion of people and emotions.** Storyboards can include renditions of human users demonstrating interactions with an interface. Designers can also use these characters to build empathy for potential users, display motivation, or convey other intangible elements, such as how the application affects the user. Alternatively, designers can also build empathy be removing people entirely and drawing the interaction as though the reader is the actor.
4. **Number of frames.** The number of different panels present in a single storyboard can vary anywhere between 1 and more than 20 frames, although the majority of storyboards we collected included between 3 and 6 frames, noted by experts to be the optimal size for conveying a single feature or activity. Multiple features and activities were usually depicted in multiple storyboards.
5. **Portrayal of time.** Designers can explicitly indicate time passing within a storyboard or use transitions that convey changes over time as suggested by Eisner [5].

Effects of the Five Elements on Designer Process and Storyboard Consumer Experience

Interviews with both student and professional storyboard artists and designers uncovered patterns of use and common

practices surrounding storyboarding in general and with these five elements in particular. Through a Web-based survey, we probed responses to storyboards that spanned the range of potential values for each element and uncovered patterns in their effectiveness for both familiar and novel user interactions. Familiar interactions included scenarios like sending email or text messages and checking in for an airline flight. Unfamiliar interactions included home automation using a specialized piece of jewelry [13] and controlling a public video game on a large display using a mobile phone [4].

How Much Detail Should Be Included?

Most students created storyboards containing screen-by-screen steps through an interface and functionality. Interviews with a subset of these students indicated that novice designers (or at least novice HCI practitioners) fear they lack the artistic ability to draw the environment and the context of use. This concern over artistic skill also led them to avoid hand drawing their storyboards using pencil and paper, relying instead on tools like Microsoft® PowerPoint® and Microsoft® Paint or traces of other drawings. Novice designers also created storyboards as a series of screenshots of non-functional interfaces rapidly created using tools like Visual Basic® (see Figure 1).

Expert designers, on the other hand, reported having the artistic ability to create highly detailed drawings and used a variety of tools and techniques for creating their storyboards. After iterations on initial pencil drawings, they recreated these drawings using ink pens or advanced graphics tools such as Adobe® Photoshop® and Adobe® Illustrator®. Depending on the audience for the storyboards and the time available for creation, experts also mentioned developing any variety of artifacts, from stick-figures with little background or detail to the use of photos or animation to create a potentially more realistic storyboard. When using photographs or stock images, a common practice reported is also to apply filters, thus removing unnecessary details and anonymizing the characters in the panel.

Significantly, all of the experts noted that this removal of detail about the human characters and about the background is important to the artist's ability to control where a storyboard consumer's attention is focused. Removal of details in the storyboard, whether through filters or using stick figures, is similar to the notion of greeking text in paper prototyping, in which designers represent text as squiggles when the actual content is not the central point of focus [12]. By simplifying some aspects of the storyboard, it focuses the storyboard consumer's attention on others.

Although most professionals encourage using minimal detail in creation of storyboards, every novice we interviewed either used a lot of detail in storyboards or noted that more detail would have been included if the design team had included more artistic talent. The empirical data backed up the recommendation of the designers, for the most part. After examining the same story (one of an unfamiliar interface) with stick figures and with a detail rich drawing, survey participants commented that the detail was unnecessary and their understanding of the story the same: *"the person who drew as much detail as [the more detailed storyboard] just wasted their time."* In the case of a familiar scenario, highly detailed storyboards can even impede understanding: *"[the more detailed storyboard] seems to have too much extraneous detail, to the point that you're not sure what the emphasis is on."* Highly detailed storyboards can indicate to end users *"that one might imagine that one should be getting more out of it than there is to get."* Despite the general recommendation of including as little detail as necessary, inclusion of more details can have its advantages: *"Aesthetically, I like [the storyboard with more detail] better."*

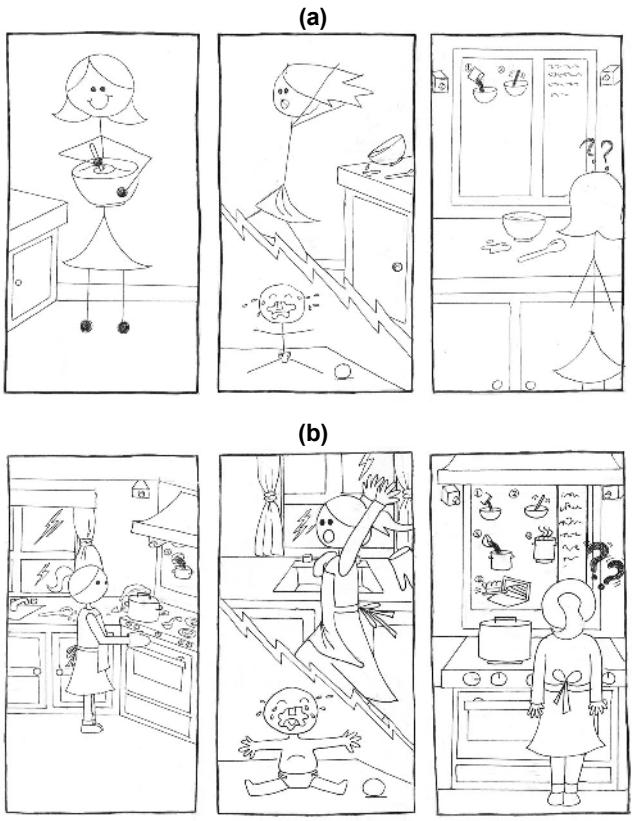

Figure 3. *Two storyboards depicting an application that monitors activities inside the kitchen. (a) shows less detail than (b). Users found the extra details in (b) distracting and did not know where to focus.*

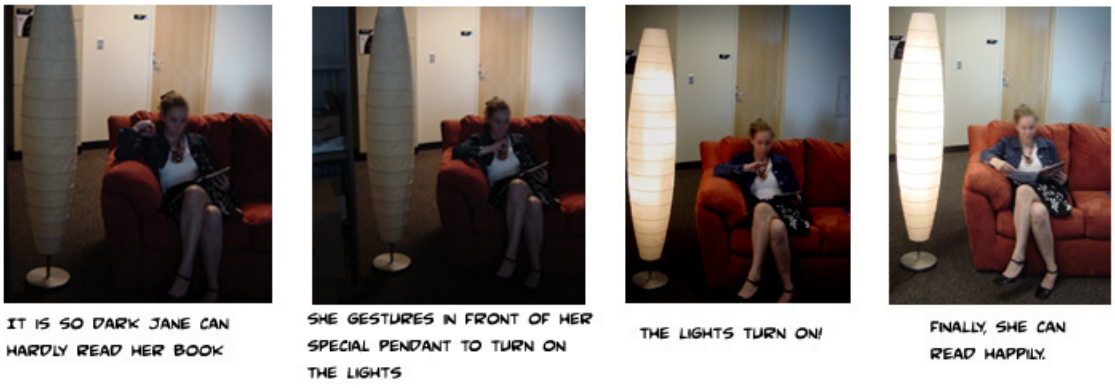

Figure 4. *Example of storyboard that included text taglines. We also presented a similar version of this storyboard without the text.*

How Can Words Alter Perception and Understanding?

Novice designers often expressed the need to explain their storyboards, implying that pictures are not enough. They mentioned that a short textual description of the situation can help explain a usage scenario, primarily because the drawings do not include the environment and people, as mentioned above. Expert designers also reported using text to supplement the drawings. Their drawings often include the environment and people, together with a short tagline to explain points that would have otherwise required much more detailed drawing to portray.

Not surprisingly, in the empirical study, use of text was one of the strongest indicators of whether or not a storyboard would be understood, particularly for novel applications. When storyboards contained text, 84.4% of the responses (151 out of 179) correctly identified the story. Without text, survey participants had a harder time identifying the story depicted; only 65.7% of the responses (69 out of 105) were correct. When we controlled the presence of text for certain storyboards, 39.7% of the responses improved when text was included. Furthermore, the amount of text matters. Short forms of included text (*e.g.,* thought bubbles or short tagline captions) were more effective than longer passages.

On the other hand, text may actually be detrimental to the possibility of evaluating the specific details of an interface or on its inherent usability, a possible concern to designers. As Truong *et al.* point out, use of words can significantly bias a user's reaction to particular technologies [16]. The qualitative responses of the survey participants indicated that in fact some scenarios were interpreted differently based on the inclusion of text. Graphic depictions should be used when designers must intentionally avoid using potentially loaded wording. In other cases, use of text, whether as captions or as wording within the scene (such as with thought bubbles or signs) may actually interfere with interpretation of the storyboard and the ability of designers to get feedback on specific elements. For example, one survey participant noted that "*all of this [the visual elements] is irrelevant in the second strip, as the text clearly spells out what's going on, regardless of the pictures. Therefore, given the explanatory text, the details and number of frames become much less important."*

When Should Storyboards Invoke Empathy?

As one expert noted, *"the first thing users will want to know is 'why do I even care about this application?' "* Experts suggest adding people in drawings to help potential end-users reading the storyboards better relate to the design.

Similar to the finding that text, while helpful, is limited in its usefulness to those situations in which designers want a certain type of feedback, showing people in the storyboards had varied results. Inclusion of human actors provided focus for the experience of application use and helped end users build empathy for these characters, a quality noted as important by multiple professional designers we interviewed. At the same time, showing only the interface allowed users to focus on smaller details, often technical in nature. When describing two versions of a storyboard depicting an instant messenger exchange, one survey participant commented that

> *"[the storyboard with people] is better for brainstorming system features, since it indicates the motivation of the users. [The storyboard without people] gives me a better idea of the desired layout of the system."*

Another respondent noted that it

> *"depends on what you are trying to convey. If just doing the technical aspects, [storyboard without people] works. If doing the whole user sequence, [storyboard with people] is better.*"

Finally, storyboards without people explain the basic story whereas storyboards with people can convey additional meaning. One survey participant noted that a storyboard about using a kiosk to check in to an airline flight that included people *"says that this kiosk check-in is easier, faster, more convenient. [The one without people] just says that it's possible."*

How Many Panels is Enough?

One large point of variation observed during the artifact analysis was that of the number of panels included in an individual storyboard. Storyboards ranged anywhere from one to more than twenty panels, with the majority of expert storyboards including between two and six panels. This differential can be explained by differences in the processes reported by interview participants. Novice designers reported adding extra frames to explain complicated ideas. Experts, however, suggested breaking complicated ideas into smaller concepts represented by a smaller number of panels that would maintain the reader's interest.

We systematically varied the number of panels used in the survey from one to seven in an attempt to find an optimal range for both user understanding and enjoyment. In the end, we determined that three to five panels was optimal for both familiar and unfamiliar interfaces, with understandability decreasing substantially below three panels and perceptions of aesthetic quality and entertainment as well as understandability decreasing with more than five. These variations occurred regardless of what outside knowledge or familiarity a user had with an application before viewing the storyboards.

> *I don't need the extra information in [the longer storyboard], it just makes it more confusing.*
> –regarding unfamiliar ubiquitous gaming storyboard

> *I would venture to guess that two frames is not enough to describe a story.*
> –regarding a familiar email application storyboard

When is it Necessary to Portray Time?

Although some storyboards included explicit indicators of time (*e.g.,* a clock or calendar), most either showed no indication of time passing or demonstrated it through implicit cues (*e.g.,* changes that could only occur over time such as the growth of a plant). Expert designers commented that it was not an element they considered unless a large amount of time elapses between panels. In those situations they often use explicit indicators to ensure that the reader has a full understanding of the story.

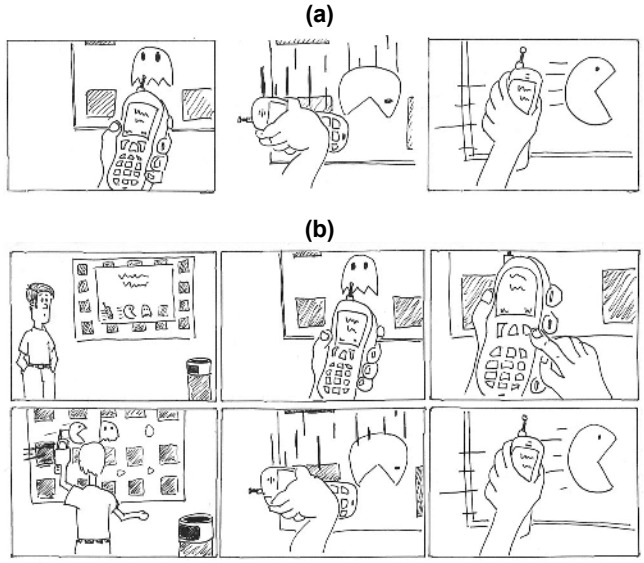

Figure 5. *Two storyboards with different lengths. Users found the extra panels unnecessary.*

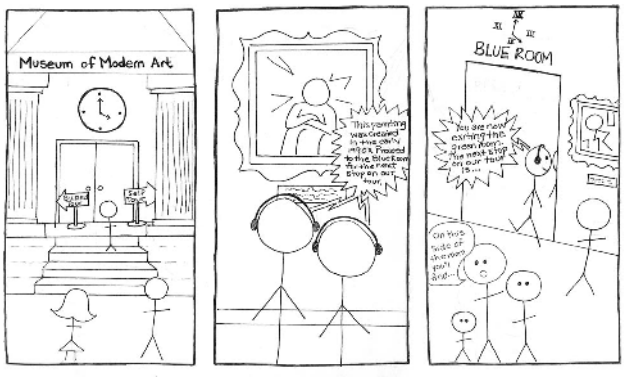

Figure 6. *Storyboard depicting an audio museum tour guide with explicit time indicators.*

Explicit references to time passing are only necessary when time is a significant element in a story. This finding echoes what experts reported knowing implicitly, that explicit mention of time is at best unnecessary and at worst distracting in most storyboards, exemplified by these survey comments:

> *Adding the date [in the second comic strip] did not improve my understanding. It was clear to me in the first one that time was passing.*

> *The inclusion of the clock in the second strip is distracting and actually hinders understanding. I don't think there's any reason to include it if it's not important that the events drawn are occurring at the same time.*

Despite infrequently appearing in storyboards, time passing was a significant element needed to understand particular storyboards. For example, in a storyboard meant to depict users taking an audio tour of a museum, although many survey participants commented that *"Time passing is implied, so a clock isn't really required,"* their understanding of the story clearly was affected by it (35.9% of the survey participants changed their answers as to what was going on based on whether or not a clock showing 30 minutes had elapsed was shown).

> *"The explicit showing of time passing (or the lack thereof)…changed my view of the situation…improving my understanding."*
> –survey participant comment regarding museum audio tour guide application

A final point about time passing that was not mentioned by either novice or expert designers, but that was uncovered by survey responses is the potentially quantifiable nature of explicit indicators of time. When referring to a set of stories

in which the sun passing over the sky is used in one of them as an explicit indicator that an entire day has passed, survey participants commented that the indicator changed their interpretation. For example, one respondent noted:

> *"Both [versions of the storyboard] have a very strong indication of a lot of time passing, but the second one shows it in a more quantifiable sense."*

If the designer needs to convey not only that time passed but how much time has passed, explicit indicators help.

The Effects of Background Information on Storyboard Interpretation

It is commonly accepted that designers should have some understanding of the characteristics of their intended end users. Likewise, the background information and external knowledge of storyboard consumers can have profound effects on interpretation. Humans are very good at filling in the blanks [7]. Thus, designers must consider how external knowledge will affect understanding.

The external knowledge of storyboard consumers can fill in holes in the graphical depictions of a story in which the designer either intentionally did not include details or was unintentionally unclear. These positive uses of background information were particularly common in the case of interfaces that might be familiar to users. One survey participant commented, "*I was able to infer from outside understanding that she was receiving a text message."*

In the case of novel applications, however, such as those that would be common to ubiquitous computing design, more often than not user external knowledge only hindered understanding. In a storyboard depicting a novel music application from Intel Research, the actor in the panels makes asynchronous requests to download music for a mobile device from her home PC. With outside understanding of an iPod® [1] that lacks that functionality, users were often confused, as one respondent noted:

> *"[The storyboard] is confusing, because it implies that the iPod is updated, but no one is at the computer back home to have updated it."*

One way to address concerns with interfering background information is to include supplementary text in the form of captions. One storyboard in the empirical study depicted a telehealth application in which a home user could initiate a blood pressure test and then proactively send that information to a health care professional. Familiarity with email and in some cases with other telehealth models interfered with every individual's interpretation of that storyboard when it did not include explanatory text. For example, one survey participant commented, "*I thought the doctor had initiated everything (mostly because of my prior knowledge of how it works)."* When explanatory text was included, however, almost all users understood the story.

But as previously discussed, text can also bias readers or possibly interfere with their understandings. Thus, another solution for hedging against a user's external information is to prepare different storyboards for different users. For example, survey participants with different email experiences interpreted panels depicting a research email client differently, as exemplified in these comments:

> *"… but I don't use Windows, so maybe it's an icon problem."*

> *"...it took me a second, because a mailbox [the icon for new mail in the prototype email clients] is not the typical icon that I see in my personal experience ...I get Outlook's envelope."*

If separate storyboards were created for users familiar with different operating systems and email clients, interpretation would likely have been less confusing.

GUIDELINES FOR STORYBOARD CREATION

The results discussed above can be generalized into the following set of guidelines that can be applied coupled with traditionally accepted HCI and design practices. Both novice and expert designers can benefit from use of guidelines for the process of creating storyboards and for the creation of the storyboards themselves.

Understand the Storyboard Consumers

It is commonly accepted that designers should consider the backgrounds and experiences of their intended users when creating prototypes. In the case of storyboard prototypes, however, this external information can be even more significant, particularly to the understanding of novel systems and applications. Thus, the first step in the storyboard creation process must be a firm understanding of the users and their backgrounds as well as of the system and its features. Designers should consider with which computing systems the consumers of the storyboards may be familiar, including icon and wording choice.

Get Creative in the Story

The next step in the process, already common to both expert and novice practice, is to brainstorm about the story together as a group of designers. During this period, all experts reported needing to be as open and creative as possible, including often altering the physical environment in which the design team is working to create a more creative space. Once the story has been decided, understanding about it coupled with understanding about the users and the system can help the design team begin to formulate the storyboard itself.

Create the Artifacts

The first step in creating the storyboard artifacts is to break each story into smaller discrete sections. Three to five sections is optimal in most cases. Experts commented that an application requiring more than five sections to convey functionality should be broken into several storyboards each focusing on an individual feature. A single short sentence should be able to describe each discrete section. The final steps then begin with drawing sketches corresponding to each of these short sentences. These sketches should use

appropriate levels of each of the attributes laid out in this paper, with the following recommendations:

- Use some **text** when demonstrating novel applications, but be conscious of how the chosen words may influence your end user audience.
- Include **people** in the storyboards when needing responses to the interaction experience. Avoid including people if detailed feedback on usability, technical, or aesthetic features is required.
- Explicitly indicate the passage of **time** only when time is relevant to demonstration of a particular feature. Otherwise, use implicit indicators of time.
- Use the minimal level of **detail** required to note the salient features of a system. Any more detail will be both a waste of designer time and a distraction from the points of focus of the storyboard.

Test and Iterate on the Storyboard

Individual designers should return to the group for feedback and iterate on the work. Every storyboard should be piloted with similar participants to the target end user group, a common practice for any prototype to be used in evaluation.

APPLYING THE GUIDELINES IN PRACTICE

We shared these guidelines with an introductory undergraduate HCI class similar to those from which we drew the original artifacts. The course consisted of 41 second to fifth year students who majored in Computer Science, Computer Engineering, Electrical Engineering, Management, Psychology, Industrial Design, Bio-informatics or Computational Media.

We asked students in this course to create storyboards using the recommended guidelines described above and recommended use of the common tools employed by experts (*e.g.,* Photoshop®). We then gathered and analyzed their storyboards and interviewed five of these students. The results of this artifact analysis and these interviews unveiled significant departures from those artifacts created in previous semesters and the way they were used:

1. Students identified a 4 to 5 line message describing the story. They created their storyboards around this story and often included short taglines for each panel in their storyboards to guide the user.
2. Storyboards included more actors and physical objects to help ground the context of use. Students reported this feature helped users better relate to their designs.
3. The level of detail found in many of the storyboards created by the students resembled those in the professional storyboards we analyzed. Students felt more comfortable using stick-figures or block-figures in their drawings and remarked about how users found this made it easier for them to understand the storyboards. Additionally, several project teams applied Photoshop® filters to photographs in their storyboards to blur out unnecessary details while preserving the features on which they wanted the users to focus.
4. The amount of time these students reported needing to spend explaining their project ideas to users was less than those from previous semesters. The simplicity of their drawings coupled with the presence of actors, objects and short text provided users with sufficient understanding of the context of use for the application design.

Students also used storyboards in a summative manner when evaluating their designs at the end of the semester. In the majority of the projects, students reported evaluators suggesting changes to the application that would not have been provided as part of other techniques, such as a heuristic evaluation, because evaluators were better able to understand the context of use.

CONCLUSIONS

Storyboarding is an important process in design and a difficult skill to apply effectively in practice. The designers, particularly novices, can lack the skills needed to create both a compelling and understandable story and a visually appealing and intelligible set of frames. By understanding current expert practices of professional designers for creating storyboards and the design requirements of a storyboard, we have been able to develop a recommended process to guide design teams in the creation of storyboards

Different classes of applications require different levels of emphasis on the various elements of a storyboard. Thus,

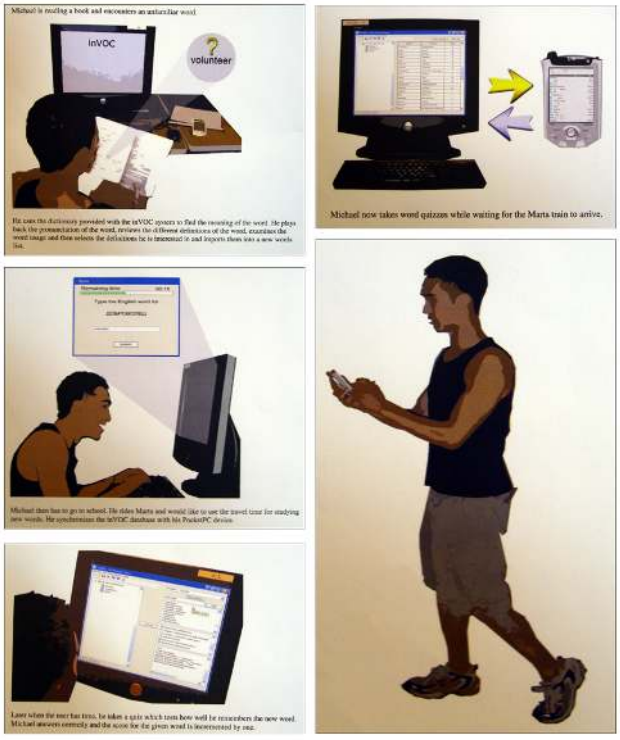

Figure 7. *Storyboard created by novice designers using the guidelines described above.*

there is no one template for all applications. As a first step, by using the recommendations laid out for each of the attributes and attending to the discussed design process for storyboard creation, design teams should be able to create storyboard prototypes to give them feedback on all levels of a system from use cases and context to specific details.

This study allowed us to uncover both current practices of professional designers and recommendations for a new process, likely to be successful for both on- and off-the-desktop applications. We identified important attributes of individual storyboards and empirically measured the understandability of storyboards created with varying values for these attributes, leading to guidelines for developing storyboards using these elements as building blocks. Using these guidelines as a process, novice designers can create better, more understandable and enjoyable storyboards.

Interviewing novices and professionals revealed that there is no one application that offers all of the functionality needed to successfully develop storyboards. A next generation application for storyboard creation should include reusable components including stock photos and clip art and layering features. It should allow users to import their own images and filter and manipulate them.

These guidelines can also be applied as part of a design tool to support storyboards design and development. First, the design tool should encourage designers to identify the story they are trying to tell in 3-5 lines. These 3-5 lines then become taglines for the panels. The drawing tool should support many of the basic features in Photoshop®, Illustrator® and PowerPoint offer that experts liked. In particular, experts liked PowerPoint because it was easy to insert, delete, place and resize simple objects, shapes and text. All experts liked the layering ability that these three applications provided. It allowed them to save and add different version of their storyboards easily. Additionally, we noticed the importance of being able to share and be inspired by artifacts created by other members of the design team. For experts, this meant a wall where early copies of individual's storyboards were pasted. For novices, this meant being able to easily glance at what others were creating. A design tool should take into consideration ways to allow a collection of designers to be able to show what they are creating and allow members of the same team to observe and easily borrow artifacts from other members.

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