

Don't drop it! Pick it up and storyboard

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ABSTRACT

Storyboards offer designers a way to illustrate a narrative. Their creation can be enabled by tools supporting sketching or widget collections. As designers often incorporate previous ideas, we contribute the notion of blending the reappropriation of artifacts and their design tradeoffs with storyboarding. We present PIC-UP, a storyboarding tool supporting reappropriation, and report on two studies—a long-term investigation with novices and interviews with experts. We discuss how it may support design thinking, tailor to different expertise levels, facilitate reappropriation during storyboarding, and assist with communication.

Author Keywords

Storyboard, reappropriation, design tradeoffs

ACM Classification Keywords

H5.2. User Interfaces: Prototyping.

INTRODUCTION

An integral part of creating and sharing ideas involves the creation of visual narratives in the form of *storyboards*. Originally used by those creating cartoons, movies, and commercials, they excel at highlighting the most important aspects of a narrative [7,8]. Storyboards depict actors engaging in a series of actions with an intended purpose in mind—often in the form of simple sketches. *Wireframes*, another form of prototyping, focus on the look, content, and connections for an interface [2]. While both are different in content, presentation, and use, researchers in human-computer interaction (HCI) and user experience (UX) professionals greatly benefit from using storyboards and wireframes to illustrate how users interact with a system [2,3,19]. Both are powerful when used to communicate current practices and/or those newly introduced.

In making a storyboard, consideration must be given to

major artifacts, such as technologies or settings, used to depict a narrative for a design. Different and more specific artifacts, such as widgets and controls, come into play when creating a wireframe. In doing this, designers often try to identify new ideas leading to novel solutions through creative efforts. Encompassed in artifacts, solutions can be collected and connected to each other to illustrate a series of key actions. These artifacts reflect vital functionality and therefore, can be critical to how a system is designed.

We also recognize practitioners often turn to ideas that stand the test of time. For example, the basic design elements of microwave keypads, spreadsheets, and webpage layouts maintain the same principles. While new iterations are produced, designers continue to naturally *reappropriate* ideas from the past and incorporate them into new designs—providing motivation to build upon previous work [27]. Improvements on prior work can enable designers to potentially continue to maximize successes while avoiding or mitigating pitfalls and lowering costs. HCI has focused on the methods for reappropriating design components often in the form of design knowledge [5,10,12,21] and has shown its benefits for usability [26].

Storyboarding and wireframing are supported by tools developed both by academia and industry such as DENIM [17], SILK [13], Illustrator, Visio, Axure, and OmniGraffle. We notice the tools can be grouped as those that focus on sketching capabilities for storyboarding and those that encourage depicting the look and feel for wireframing. In these tools, sketches can be highly creative ways of elevating core *ideas* while reducing emphasis on details that are unimportant in storyboards. Wireframing tools for the visual aspects of software, some *incorporating* components from widget collections, highlight details closer to production. Our goal is to reappropriate core ideas in creating what is a hybrid of storyboards and wireframes—filling an unaddressed void.

Thus, the research trajectory leading to this paper focuses on the notion of reappropriating ideas represented as artifacts. We want to emphasize both the use of imagery and design reflection when using artifacts that might serve the purposes of a design. For simplicity's sake, we refer to this hybrid approach as storyboarding due to its emphasis on imagery. Previous work focused on creating a card-based artifact set that combines both inspiring imagery and

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CHI 2011, May 7–12, 2011, Vancouver, BC, Canada.

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design tradeoffs [25]. The cards could be sequenced together to create storyboards depicting new systems [24].

With this work, we aim to contribute the idea of storyboarding through reappropriation of artifacts and their design tradeoffs. As advocates, we prioritize collecting and sharing artifacts and their tradeoffs within a community—an aspect mostly overlooked by other tools. We introduce a storyboarding tool, called *PIC-UP*, as an example of how one could enable such an approach. We present two studies in which we were concerned with not *what* can be designed, but *how* one might reappropriate and share while storyboarding toward situating PIC-UP within the tool space. We deliberately focus on studying how to enable reappropriation and not on the creativity or quality of the storyboards. In our first study, we deployed the tool for two months within a community of novice designers to observe storyboard creation and artifact sharing. We then present interviews conducted with expert designers to identify an appropriate target user group and possible uses. Finally, we review the results and discuss PIC-UP.

RELATED WORK

Storyboarding is typically illustrated as a creative process of describing a user's interaction with a system over a span of time through a series of pictures, often sketches, and a textual narrative. Truong et al. mention the portrayal of time, the use of people and emotions, the inclusion of text, and the level of detail as key aspects of storyboards [22]. They are used to depict the flow of a story, reduce costly elements of design, and propose ideas to stakeholders [3,18]. Thus, they are early low-fidelity prototypes in the design process.

On the other hand, some product features might come about as a result of previously existing solutions. The reappropriation of existing design solutions has been researched by many to reduce development time and costs [6]. Its value has been seen in industry in different situations. For example, the IDEO Tech Box serves to collect and store objects that can inspire and improve the design of products [3]. Designers often refer to examples that could be intergrated into their work [9]. Patterns, knowledge structures that incorporate contexts of use, conflicting forces, and potential solutions, are adopted by HCI as a form of design rationale [5]. The Yahoo! Patterns Library is an example of a repository that stores components to be reappropriated for web design [28]. Claims, are another form of design rationale emphasizing the consideration of a feature's design tradeoffs [4] and can also be utilized in repositories [21].

Tools from academia such as SILK [13], DENIM [17], and DEMAIS [1] facilitate storyboarding early in design while emphasizing their visual nature. These tools have a heavy focus on sketching capabilities for the prototypes being created. Damask [14] is a recent storyboarding tool meant to support design pattern reappropriation. It does not necessarily support growing the collection of patterns to

further future reappropriation. Within industry, tools such as Visio, Axure, and Omnigraffle are used to build wireframes. Even these tools do not strictly adhere to the key tenets of storyboarding—excluding aspects like actors, emotions, and narratives. While they might have a library of components used to create storyboard elements, they are not meant to evoke explicit design tradeoffs consideration.

The IDEO Method Cards [11] and Friedman's Envisioning Cards [16] are card sets aiming to inspire through stunning imagery and provoke thought about the design process through nuggets of informative textual descriptions. More recently, the IDEO Method Cards were released again as a mobile phone application to share easily—demonstrating a trend toward digitizing such card-based approaches. A card set integrating pictures of possible design features on the front with tradeoffs on the back was also researched as a possible method for creating storyboards [25].

The work presented in this paper seeks to blend the issues mentioned. We carve a new direction by taking advantage of the visual and storytelling capabilities of storyboards while enabling the reappropriation of existing solutions through explicit design tradeoff consideration.

REAPPROPRIATING AND STORYBOARDING IN PIC-UP

Previous investigations on the use of physical card decks for storyboarding and reappropriation and a review of design tools, led us to consider how software leveraging cards could extend this activity [24]. Based on an analysis of what designers did, we created a digital tool called PIC-UP (Figure 1). We aimed to provide designers exposure to a collection of artifacts and their associated tradeoffs, mechanisms for searching for appropriate artifacts, guidance through basic design principles, and ways of contributing artifacts to share with others.

Artifacts as Cards

Each artifact or feature in PIC-UP uses a *card* metaphor. Cards have a *label* and an *image* on the front and associated *design tradeoffs* on the back (see 1 in Figure 1). Users can flip cards to see both sides—inspiring both creativity and rational thought. We intend for the images to serve as mechanisms to attract attention to cards and inspire new ways for how they can be reappropriated in a storyboard. We also encourage designers to consider the impact of using the artifact by referring to the advantages and disadvantages. A storyboard is created by gathering and sequencing cards to illustrate a *scenario* of use in a series of frames. Each frame contains one or more cards.

The storyboard with generic images, tradeoffs, and a narrative is non-traditional as it forgoes sketching—a tenet of storyboarding [3]—but actors and emotions are still included in the narrative. Because the images are high-fidelity representations of objects that may be used, it also borders wireframing—a visual skeleton depicting content and navigation [2]—but does not focus on the final look of the system being designed. Because we believe the

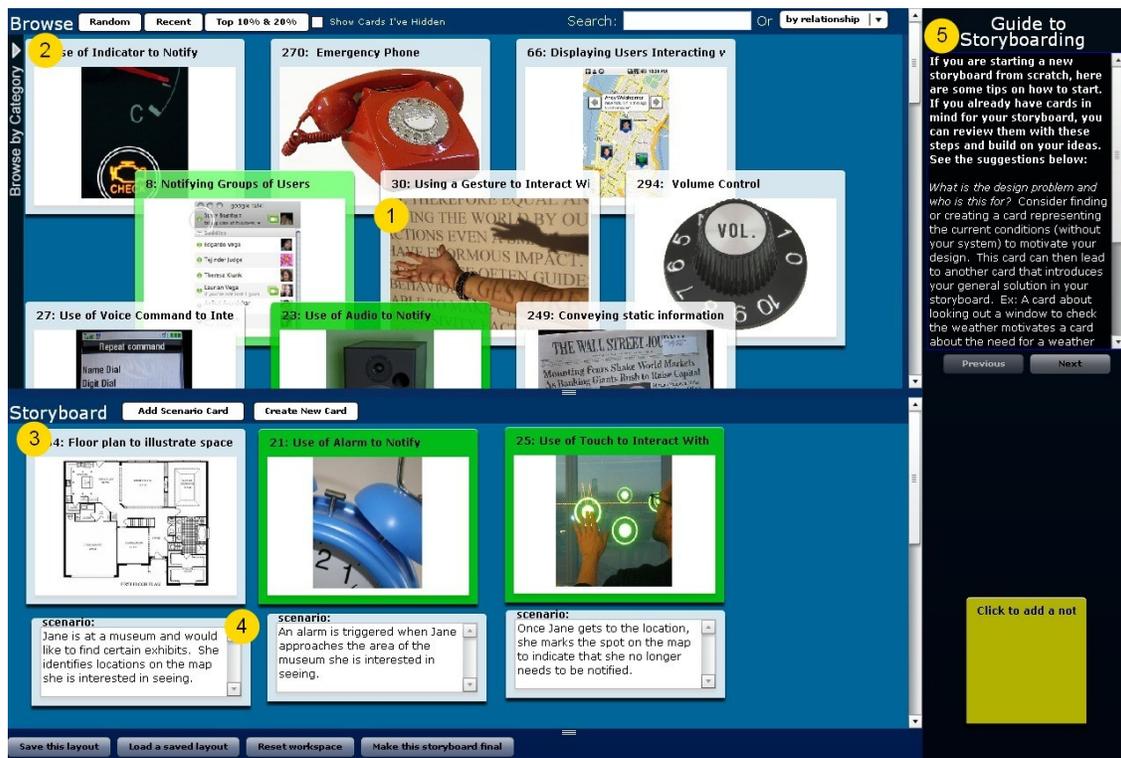


Figure 1. PIC-UP is a storyboarding tool supporting the reappropriation of design ideas in the form of cards. Users look for cards in the browse space. Cards are collected and sequenced in the storyboard space. A narrative is added to complete the storyboard.

majority of characteristics most closely resemble a storyboard, we choose to use this term.

PIC-UP leverages cards collections from targeted areas or domains. The cards focus on a class of systems called *notification systems*—products built to manage dual-task situations and the interruptions that might occur [15]. Users are encouraged to contribute new cards to facilitate growth and sharing. A designer must provide a label, picture, and short description of a feature and its positive and negative tradeoffs to make a card. We deliberately chose to keep the structure simple by using a list of design tradeoffs—instead of Damask’s approach of using patterns [14]—to reduce the burden on users. Cards can be edited to suit needs. When created or edited, it is only available to the creator. We believe the need for new cards is established once it is integrated into a storyboard. We avoid storing temporary cards and retain them in saved files. After a storyboard is submitted through a finalization process, the new or edited cards are permanently stored for others to see.

Card Spaces

PIC-UP uses two spaces in which cards are manipulated: browse and storyboard. Cards are dragged from the browse space, containing the card collection, and dropped into the storyboard space, an area for storyboard assembly.

Browse Space

The browse space has several methods of searching and filtering through cards (see 2 in Figure 1). Apart from a

keyword search, users can view a *random* set of 30 cards. This view provides initial exposure to the collection for possible inspiration. The *recent* view displays the last 10 new cards created by the community so that users are aware of new additions. Users can also view cards that belong to certain *categories* related to specific kinds of notification systems—giving a way to find what might be appropriate while also familiarizing users with the domain.

The browse space also allows cards to be seen in a *detailed view* mode (Figure 2). This shows both the front and back of cards together and the number of times it was used by others. In addition, it shows all cards that share a *relationship* with the selected card. There are 8 relationships that are semantic connections [23] established between cards by users of the system. (The relationships are described later.) Clicking on a related card allows one to navigate to it—offering a browsing mechanism for discovery of other relevant cards to reappropriate. Users can also choose to see cards with a certain relationship by using a *relationship search*.

Because of user generated content, some cards may be more useful than others because of language, scope, applicability, and imagery. We anticipated needing to elevate cards that offer strong solutions. This could be done through expert reviews or voting, but currently we use the number of times a card is previously used to indicate a measure of strength since we believe usage implies some perceived benefit. For the scope and size of our collection, this reduces the need

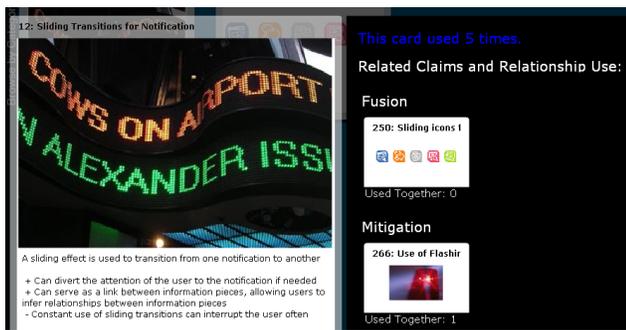


Figure 2. The detailed view shows the label, image, and design tradeoffs of a card. It also shows how many times the card was used and links to related cards through relationships.

for moderation or explicitly collecting information from others. The top 10% and 20% view shows the most used cards, indentifying cards that emerge in importance over time. These cards are color-coded with shades of green indicating their usage throughout PIC-UP.

Storyboard Space

This section provides a canvas for collected cards (see 3 in Figure 1) so they can be sequenced to create a task flow representing the progression of a story. One can then add *scenario cards* to write a narrative for each storyboard frame (see 4 in Figure 1).

Designers often realize the need for artifacts that might not be available as the scenario is formed. Cards included in this space can be edited to fit the context of the storyboard. Additionally, cards can also be created and stored for others to see when the storyboard is finalized.

While the storyboards are non-traditional because of the lack of sketches, it is possible for one to edit a card and include a sketch as an image, but this is perhaps unlikely to occur. However, aspects such as the passage of time and the use of a narrative are maintained. Actors and any possible emotions are included in the narrative.

Storyboarding Guide and Relationships

Just as DENIM [17] and Damask [14] chose to guide designers through a tailored style of storyboarding—from overview to finer details—we adopted an approach that would tailor to the nature of our cards. We included a storyboarding guide to aid designers who may be unfamiliar with design concepts, storyboarding, and PIC-UP features (see 5 in Figure 1). Each of the seven steps in the guide probes the user with a question to consider about their design and offers suggestions on what can be done and which card relationship to use to find a card (Figure 2).

The first step asks the designer to identify the problem being solved. It then suggests including an actor in the narrative. Since the postulation relationship is established between a card representing a problem, such as checking the weather, and one offering to a solution, such as using a weather ticker, it suggests using the relationship to find a card that motivates the storyboard. The other steps probe

the designer about information presentation and interaction techniques, alternative solutions, combining artifacts to create new ones, accounting for the negative consequences of cards, and broader or narrower scopes of the cards. The relationships associated with these steps are called execution/evaluation, translation, fusion, mitigation, and generalization/specification respectively. Mitigation, for example, connects to other cards that resolve a specific downside of a card.

The last step suggests iterating and finalizing. During finalization users have a chance to add relationships between storyboard cards for others to see in the detailed view.

STUDYING PIC-UP IN USE

We conducted a study over 2 months by deploying PIC-UP to a group of aspiring designers to evaluate how it could serve a community. Our goals were to observe the creation of multiple storyboards, artifact selection processes, use of the guide and relationships, contribution of new cards, and impact of previous card usage.

Participants

Our group of aspiring designers consisted of nineteen graduate students who were all taking a usability engineering course (CS 5714) at Virginia Tech. The course is an introduction to design and evaluation methods in HCI. Their previous experiences with design and HCI varied widely. Some students were engaged in HCI research. Seven students said their previous experience was limited to HCI coursework. Three students were exposed to HCI and design work through both courses and previous jobs. Three others mentioned they did UI work before in work settings, but did not take any classes. Of all that had some experience, only three specifically had storyboarding knowledge. The remaining six had no previous experience.

Procedure

Participants were asked to use PIC-UP to design three different systems in three phases during the study. We changed some requirements for phases to observe behaviors in PIC-UP usage. Each phase asked them to turn in a storyboard containing 4-7 frames, but we did not enforce the frame requirement. All subjects worked in pairs except for one.

PIC-UP was freely available to participants throughout the study. In phase 1 they were given 1.5 weeks outside of class to design a notification system to alert airline passengers of flight status information. This phase gave them a chance to familiarize themselves with PIC-UP. In phase 2 we asked them to design a system to alert building occupants of an emergency and guide them out. We asked all the subjects to only work on the storyboard during an hour-long observed session where they could be videotaped. Following the session, we conducted a semi-structured interview to gather thoughts on the storyboard, card selection, the guide and relationships, card creation, and previous card usage. This

phase allowed us to observe how certain artifacts can be shared within a community when solving a common problem. In phase 3 we allowed the subjects to choose what to build over 1.5 weeks outside of class, but required them to follow the guide in PIC-UP. This last phase gave us insight into the growth of the collection and the effects of structuring the design process. After all phases, we conducted semi-structured interviews with fourteen of the students to hear final comments on the experience and longer-term impact.

Data and Analysis

For each phase we gathered storyboards, logs, and design journals providing system descriptions, notes on how storyboards were created, and reflections on PIC-UP. During the observed sessions and interviews, we made video and audio recordings. We analyzed the storyboards, journals, and interviews based on the open coding technique [20] which led us to identify categories related to card selection approaches, guide usage, design learning, card creation, and identification of highly used artifacts. The videos were consulted when transcripts referred back to events during the observed session. Logs were mined to gain an overview of key actions and collection growth.

PIC-UP Prior to Deployment

Before the study PIC-UP contained 54 cards created by us and others during a series of small-scale deployments. There were 53 relationships established between the cards with some cards being more connected than others.

Results

We now turn to the results of our study with our aspiring designers. We aim to present the range of activity that took place when reappropriating during storyboarding and comment on the impact of PIC-UP.

Construction Approaches

There were 11 storyboards produced for phase 1, and 10 for phase 2 and 3 (see Figure 3). Overall, we found the size of the storyboards remained mostly constant, indicating no drastic change took place. In phase 1, the storyboards contained 5-14 total cards, averaging 6.9 total cards and 1.46 cards per frame. Phase 2 had a total number of cards ranging from 4-13 with an average of 7.1 and 1.61 cards per frame. In phase 3, there were between 4-13 cards with a total average of 7 and 1.52 per frame.

We found there were two approaches to choosing cards: taking a *card-first* approach and creating a scenario out of what is available or a *scenario-first* approach where a predetermined scenario drives the selection and creation of cards in the storyboard. This was illustrated when a participant posed a choice during the observed sessions: “How do you want to start...by looking at the cards first or by writing down some ideas?” In response, her partner said, “I was going to say we discuss some stuff and try to come up with some vague idea for what our system is.”

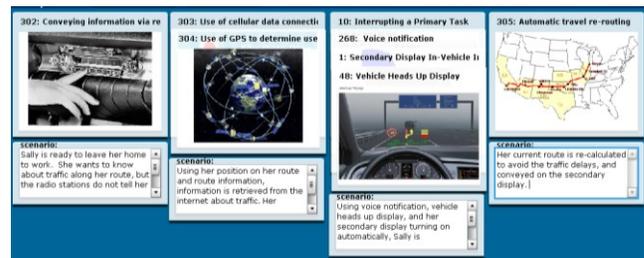


Figure 3. An example of a phase 3 storyboard with 4 frames and 8 cards. Each frame has a scenario card.

We found a majority of the storyboards followed the scenario-first approach. During the observed sessions an average of 4 minutes were spent determining the scenario. The pairs would agree on the basic ideas for the design by discussing possibilities. One student described the initial brainstorming: “We would typically do pen and paper prototyping first and do a rough sketch and do a stick figure drawing and that’s when we would hash out stuff and spend time on the system.” Another pair chose to record ideas in PIC-UP during phase 2: “My partner and I started by thinking about the design of an emergency notification system and then by writing the scenario cards for our design. This helped us clarify our ideas and identify what could be improved. This also helped us choose all the different cards to illustrate our scenarios.” Students then proceeded to choose cards by mapping them to the scenario.

When asked about the card-first approach, respondents generally agreed it did not seem to be the ideal approach: “I remember flipping through the cards and trying to apply different scenarios to the cards. It was very inefficient because I was matching a scenario to a card instead of the card to a scenario.” We found some examples of the approach in phase 1 and only one example in phase 2. Previous work showed a card-first approach was chosen more with a finite set of physical cards [24]. PIC-UP, with a larger collection, might be causing such a change, but a scenario driven approach is what traditional storyboarding would advocate and we are encouraged by this.

Inspiring New Ideas for Reappropriation

PIC-UP can inspire new thoughts while following a scenario-first approach. In looking for artifacts to reappropriate, a participant explained plans often changed: “We came across other cards that, while not what we were searching for, turned out to be applicable to our project, and we altered our envisioned system to reflect the new ideas that we had generated based on the cards.” The images often played a key role in attracting attention and inspiring certain ideas during the search, but it is often checked by referring to the design tradeoffs. A student explained this by saying: “The image I think just helps us to catch our attention at first ‘cause there were cases...we flip through the [tradeoffs], maybe the image might semi-work, but when we saw the [tradeoffs] we’re like ‘ok no this isn’t the type’ so ultimately it really would probably be the [tradeoffs]. The image we can always alter.”

Reappropriation of cards can be highly dependent on how relevant their tradeoffs are. This is prominent when designers are faced with choices: *“When we were trying to decide which card to use when there were two similar cards we flipped each card over and compared the [tradeoffs] on the back. After comparing the two, we decided on which one was more [like] what we had envisioned for the system, and then chose to add that one to the system.”* Participants flipped cards 126, 115, and 88 times in phases 1, 2, and 3 respectively. Participants acknowledged this is an important activity when seeing cards initially. We believe it decreased due to increased card familiarity over time.

Searching for Cards

Based on journal entries, card-first approaches used the random view. The view was not used as much in the scenario-first approach. When looking for a very specific kind of feature related to notification systems (such as an alert method) participants referred to the category view since cards were organized by type. The final interviews found this served to illustrate core concerns of notification systems, better familiarizing users with the class of systems.

Interesting issues came up when we looked more closely at the recent and top 10% and 20% views. The recent view, showing the 10 newest cards, played an important role in phase 2. Since everyone was working on the same problem, designing a system for building evacuations, new cards had the chance of being relevant to other storyboards. An example of a card shared and reappropriated within the community was one called *lighted directional path*. The artifact was about using lights along a path to guide people during an emergency. The picture showed emergency lights along the aisle of an airplane. Many individuals had thought of similar ideas and when one person looked at the recent view and saw that it was already made, he reacted by saying, *“Someone made that for us! Sweet.”* As others used it, the card broke the threshold and acquired a green status, placing it in the top 10% and 20% view. This example shows reappropriation can directly benefit efforts to solve a problem. However, this also illustrates the recent view may only be useful when everyone works on the same problem.

Impact of Previous Reappropriation

We wanted to see how knowing the number of times a card was previously used impacted reappropriation. The top 10% and 20% view led participants to express different opinions. Since this shows the most reappropriated cards, it elevates those that stand the test of time. We believed the view and green cards would let designers quickly identify cards of higher perceived value. One participant who thought similarly said, *“Highly [reappropriated] cards could provide a starting point for designers, in that those cards could contain high level ideas applicable to a wide range of products.”* Another student explained the benefit for him: *“I used the most frequently used cards as a starting point for my exploration of options in the ideation stage. The most popular cards were usually applicable in some way to the*

system I was tasked to create. Also, looking through the cards that other users had chosen gave me an idea of how they solved the design challenges.” On the other hand, we found previous use is not necessarily a key factor: *“Just ‘cause they use it a lot doesn’t necessarily mean that it’s going to fit with what you’re doing.”*

We realized there were a lot of strong views about whether something should be used just because it was reappropriated by others as we probed further into this last comment. One respondent in our phase 2 interview explained it this way: *“Yeah, I don’t even like allowing [previous use] to influence...I mean honestly I could even imagine myself being biased in the other direction...just wanting to use cards that haven’t been used much before so I don’t feel like I’m doing the same thing that everyone else did.”* Another informant gave an example of how this notion might negatively impact them: *“While considering popular cards can be efficient, it can often hinder creativity and sometimes cause designers to implement the wrong type of system for a designer problem. For example...we immediately looked to implementing a mobile system because that card was most used...after thought, we realized that a mobile system would not be [appropriate].”* Even though the ability to reappropriate artifacts in new designs is not being challenged, it seems there is discomfort regarding a potential loss of innovation if users feel they are reappropriating the same solutions over and over again.

Guide and Relationship Use

We observed a different way of impacting reappropriation in phase 3 with the guide requirement. The guide was previously ignored because either they felt they knew what to do or did not notice it. Only 4 pairs showed limited activity with the guide in phases 1 and 2. In phase 3, all pairs used all the steps of the guide. We found the overall impact of the guide was to give a sense of targeted reappropriation. When discussing overall thoughts, one participant said, *“One benefit of the guide was that it prompted users to think about things that they may not have thought of before. For example, we never really considered adding additional things in our storyboard that may help explain the system we are designing.”*

Each step prompted them to consider reappropriating certain types of cards. For example, in the first step a subject wrote in his journal that they, *“...wanted a card that presented the problem of blind spots which subsequent cards would solve.”* For the second step, in which they were asked to consider information display methods and interaction techniques, a participant said, *“Here we identified that we wanted to deliver the information as text with links to more information.”* In the fifth step, where negative design tradeoffs are identified and resolved, a student wrote, *“Originally, we had not thought of any possible negative outcomes until we looked through the mitigation cards. Then we realized that there was a chance the user might not hear the verbal notification.”* We notice

these kinds of actions were only mentioned in phase 3. They are indicative of a form of design learning that took place—especially considering they initially saw no utility in the guide. However, based on feedback, we also see the guide may only be used initially and ignored later, once the core lessons are understood, to avoid its prescriptive nature.

Relationship usage depended on the conditions of the phase. In phase 1, logs indicated users followed relationships 9 times in total and used the relationship search 46 times. In phase 2, the numbers were 59 and 22, indicating a greater reliance on following relationships. In phase 3, it was 17 and 81, this time favoring the relationship search. One informant described his reaction to following relationships in the phase 2 interview: *“It’s nice that they’re categorized by the relationship, but usually I’m just clicking on it to see what other cards are associated with it ‘cause that’s not exactly what I’m looking for but close...”* Most participants initially used relationships to browse without grasping their full potential.

In phase 3 they began to see what relationships were really capable of since each relationship was tied to the guide—explaining the increase in the relationship searches. This change in thinking was portrayed by one participant: *“The guide introduces you to the power of the relationships. Not in a sense of finding more cards, but a power in the sense that the relationships help you make sure you cover all the spectrums for your storyboard. You don’t want multiple cards when you could generalize. You don’t want a postulation card without its solution card. You don’t want a card without using its mitigation card because this minimizes the cons of your storyboard.”* It is notable the role each artifact plays in the design is considered.

Participants mentioned they did not always find what they needed due to the small number of relationships. We did, however, see the number of relationships created grow over time. The relationship count went up by 30, 47, and 26 over the three phases. For example, the *lighted directional path* card was eventually connected to 5 other cards. There was a sharp increase in new relationships in phase 2, but this fell in phase 3 despite a larger number of new cards. We believe many new relationship assignments that may not have been strong were added. We posit the number fell in phase 3 because the participants better understood the concepts and only created relationships that matched their description in the guide. This may indicate the guide should be consulted the first time to better explain the relationships.

Creating Cards

We also looked closely at card creation as it is a large part of reappropriation and sharing. The number of cards grew by 3, 6, and 14 in phases 1, 2, and 3 respectively. All the participants created a card at some point. A participant explained there was one sole reason for trying to create a card: *“...the fact that we couldn’t find a card with the right kind of [tradeoffs] for what we had in mind.”* When deciding to make a new card, we observed participants

taking other cards as examples and learning from how they were scoped and worded. An informant described how he created a new artifact: *“We took our time in creating our card, making sure that it contained the kind of information that would help us in this specific instance, but also making the [tradeoffs] broad enough so that others could use it in the future. We also included a fair number of [tradeoffs]... since we came across some cards that were lacking...”* In one instance, we came across a pair in the observed session that decided to use a card they created in phase 1. When deciding to do so, one of the partners said, *“Hey if we keep using this, this will eventually go up and...get green status.”* These examples demonstrate that the novice designers strive to balance how generic or specific a card is to maintain its applicability—often intertwined with a sense of ownership for their cards. It must also be mentioned that we are cautious about new cards since the utility of PIC-UP might rely heavily on the number of new cards being contributed and, particularly, on the quality of those cards.

INTERVIEWS WITH DESIGN EXPERTS ON PIC-UP

Our first investigation painted a picture of how novice designers could learn storyboarding elements and reappropriation while appreciating the value of design tradeoffs. As we were encouraged by some of the positive impacts the tool had, we wanted to find out who else this form of storyboarding could tailor to and how it might be used. To that end, we conducted interviews with experts about their work and thoughts on PIC-UP.

Seven informants were recruited from both academia and industry. We talked to a UX researcher, a UX designer, a UX manager, 2 professors (one of whom spent significant time as a designer in industry), a director of a usability consulting group, and a researcher at a large corporation.

The one-hour sessions were carried out via phone and screen sharing. Audio recordings were made. We first conducted semi-structured interviews about their background and existing design practices. They were then asked to read instructions and follow a sample task taking them through designing a notification system for museum visitors in PIC-UP. The task was designed to illustrate all the system features. Their actions were observed through screen sharing. Once completed, they were interviewed about their storyboarding practices and reactions to the tool.

Results

We report on the findings from our interviews. We first provide a short description of current practices and then focus on who might use PIC-UP and how communication might be facilitated.

Current Practices

We first wanted to gain a sense of how designers initially start their work on design. The professor who had a background in industry explained designers, *“start with sketching the stories of people, generally with scenarios and the construction of people and places and [them] doing*

something...” In brainstorming sessions, it was mentioned a whole team might use whiteboards or post-it notes to record ideas and storyboard during design charettes.

The UX manager explained his approach to problems in new areas: *“Over time a series of different sessions of design research and just talking and looking at...best practices.”* The director said she would try to find out what had been done before. When discussing tools, informants mentioned prototypes could be pitched using Illustrator, Omnigraffle, Dreamweaver, Flash, and PowerPoint.

When discussing reappropriation, five informants mentioned some form took place in their work. This could appear as styles, templates, and practices to maintain consistency. The UX researcher specifically advocated sharing designs and practices. A professor explained that there is no creativity without some kind of reappropriation. On the flip side, the researcher mentioned reappropriation was not an option because research demanded novelty.

Use Based on Expertise

We were encouraged to find PIC-UP may offer value to users of different expertise levels in varying roles. It was believed experts could use PIC-UP *after* the initial problem exploration since it is a solution-oriented system. Participants believed it has the potential to make brainstorming more comprehensive. The UX manager described the impact of having a storyboard at this stage of the design process: *“The idea of having an artifact to respond to...makes a huge difference for brainstorming.”* He added that the storyboard, *“might be a deliverable for an initial brainstorming phase where we might work through...a round of revisions and think about some of the pros and cons.”* PIC-UP can be a resource during brainstorming. For example, the UX designer mentioned: *“I think it would be a good resource for discovering methods of interaction or usability that I hadn’t necessarily thought of. It’s just a good way of exploring ideas or opportunities.”* Similar thoughts were also expressed by the UX manager: *“If we had an easy way to view a lot of prior work...it might help us by putting it in one visual field, to be able to review ideas...and say does this apply and be more comprehensive about the brainstorming.”* Such comments lead us to believe that experts might use PIC-UP in the appropriate design phase in addition to existing practices—most of its utility being in facilitating brainstorming.

Reasons for using PIC-UP might change for the less experienced. The UX designer suggested, *“for somebody less familiar with design, this could be their step one...a non-designer could start more from the ground up with a tool like this.”* We found that for some non-designers such as developers, managers, or clients, the sketching that comes so easily to experts can be an obstacle. The UX researcher explained the problem this way: *“A lot of the designers...they always start with sketching and that’s a really uncomfortable place to start for somebody that’s not comfortable with sketching.”* Although we cannot confirm,

perhaps this same obstacle may exist in DENIM [17] and SILK [13] since they emphasize sketching too. Additionally, PIC-UP may offer a way to synthesize initial concepts. One person stated, *“this could help those people who weren’t so familiar with UI concepts and design and things like that and give them a starting place and a method for illustrating their ideas.”* In putting these ideas together, the UX researcher noted, *“because it is a storyboard, it necessitates thinking about workflow which is something that can get lost a lot...especially with somebody who isn’t thinking about design all the time.”* For novices or non-designers, PIC-UP may reduce initial hurdles by offering the utility of generic images and a way to communicate design concepts.

Design teams with mixed levels of expertise might leverage PIC-UP too. For them it can serve as a record of work: *“This seems like a way to keep a collaborative team up to date...about what happened in a design session.”* Groups might also have to identify what the best practices are for a new class of systems. For this situation, the UX manager explained, *“this tool is a way to rapidly move towards a solution that builds in some awareness of what you’ve already done to analyze the problem, but also...on best practices in that area. So if you are unfamiliar...this tool seems like a resource to turn to...”* This strategy of learning from other work is useful for both the experienced and inexperienced designers working with unfamiliar systems.

Communicating Through Storyboards

Some interviewees mentioned communication gaps that can exist during design. We found PIC-UP might be able to make the communication more effective in certain situations. One of the professors mentioned: *“What I want to know every time I see a designer argue for a choice is show me the user centered evidence that supports that choice.”* This may be facilitated by the explicit tradeoffs in each card. Another way PIC-UP could be used in an organization was explained by the UX researcher: *“We could sort of build cards based on the needs of our own organization...because right now, that information lives in people’s heads, and if it lives in people’s heads, then it looks a little bit differently in the other person’s head, which means there’s not a common enough understanding even though there definitely should be.”* She continued by saying: *“The notification examples you’ve put together here sort of represent what we as a department have talked about wanting to do for a long time, which is creating a UI pattern library.”* We find that the reasoning for design choices and the sharing of these ideas can play an important role—placing greater importance on PIC-UP’s use of design tradeoffs and its reappropriation capabilities.

DISCUSSION

We were able to identify a range situations where PIC-UP could be used and activities that occur. We found that PIC-UP may tailor to designers of mixed expertise levels, supplement design activities, follow scenario-driven

approaches, encourage design thinking and learning, and facilitate reappropriation of artifacts during storyboarding. With these findings in mind, we discuss PIC-UP.

We understand certain pitfalls may exist. Exposure to high fidelity images may have a negative impact on creativity since too many unnecessary details might come into play at an early stage, taking focus away from the overall problem and leading to unwanted feedback. Integrating sketching could provide a different creative avenue. The quality of cards may be an issue over time. Just as good ideas may propagate, lesser ideas may also spread throughout a collection. Furthermore, the storyboard quality is unknown. The small number of cards and relationships may have a negative impact. Perhaps quality might be aided with social navigation, but its scalability is unknown. Issues related to the top 10% and 20% or other search methods may emerge with a significantly larger collection of artifacts.

On the other hand, the nature of PIC-UP—its reliance on tradeoffs, elements such as the guide, an emphasis on scenarios, and the storyboard—positions it as one that may encourage design learning and thinking. We are heartened by reports from our novice participants stating they found use for PIC-UP and storyboarding in their own research and jobs because it changed the way they were thinking about design. PIC-UP may reinforce lessons of workflow, focus thoughts on potential users, and encourage early consideration of problems to be solved—effects observed as a result of the guide. The guide prescribes a process, but student designers or non-designers in organizations may find value in initially following some suggestions. Even if one cannot find a card using a relationship in a step, we consider the actions taken to be better than inaction since they indicate the overall structure of the design is being considered—leading to reappropriation not for the sake of having a solution, but also to satisfy tradeoffs, scenario discrepancies, and task flow.

We believe PIC-UP could eventually tailor to three user groups. First, as both our studies outlined, our tool can be beneficial to the *novice and non-designers*. The interviews with academics lead us to believe they may be enthusiastic about exposing students to interaction, workflow concepts, and solutions that can be reappropriated. PIC-UP can provide students a chance to utilize technology and interact with it the way designers might. Non-designers such as developers, managers, and clients who might be involved with a design project can find ways to express their thinking. Second, our work can aid *diverse practitioner groups* that may be unfamiliar with a certain class of systems. PIC-UP can facilitate group brainstorming sessions for UX teams by inspiring ideas when starting a new project—especially for areas in which they have not worked. However, we acknowledge expert designers might resist fully adopting PIC-UP as they might prefer their existing storyboarding or wireframing methods. Third, an *organization with a vested interest collecting and sharing design practices* can take advantage of PIC-UP's

reappropriation and sharing capabilities. Such an effort can evangelize practices across an organization and help bring new designers onboard. This requires the artifacts be tailored to the needs of the organization and its practices.

Our approach to storyboarding is novel in that we embed design tradeoffs into the process. PIC-UP demonstrates reappropriation and storyboarding are not at odds with each other. Instead, they can both function together hand-in-hand. However, unlike storyboarding in SILK [13] and DENIM [17], we focused not on sketching, but reappropriation. The advantage of reappropriating existing solutions into a storyboard is that it is being done within the context of a design—similar to some of the sentiments in Damask [14]. This approach is in sharp contrast with isolated instances of reappropriation that might occur with patterns libraries, such as the Yahoo! Patterns Library [28], where a prototype is not being constructed at the same time. Additionally, wireframing tools like Axure, OmniGraffle, and Visio, with access to widget libraries to create prototypes, do not encourage explicit design tradeoff consideration. They also do not focus on narratives for context. These differences uniquely position PIC-UP in the array of storyboarding and wireframing tools. As portrayed, collections of artifacts can be beneficial in certain situations, but we also acknowledge that tensions can always arise. It is our opinion that the very presence of *tension between creativity and reappropriation is an advantage as it promotes debate about the utility and viability of the artifacts* in question.

Although the storyboard is non-traditional, we are compelled to argue there is utility in constructing this kind of storyboard for learning and communication. It tries to retain the main characteristics of traditional storyboards [22]. Elements such as the motivation, problem, key features and design tradeoffs, and the associated scenario—all contained within a PIC-UP storyboard—show potential in jumpstarting conversations about a product. It serves as a method to deliver ideas to others, such as clients or team members, early in the design process. Furthermore, it shows potential in bridging the divide between the experts and inexperienced—*allowing novices to build solutions containing the basic elements of design while overcoming potential obstacles and enabling experts to quickly pitch ideas to a non-designer audience*.

CONCLUSION

This paper investigates how storyboards can be constructed by reappropriating previous ideas—a direction unaddressed by tools currently available. We introduced a storyboarding tool, PIC-UP, that allows for a collection of artifacts, along with their associated design tradeoffs, to be reappropriated during storyboard construction. Through two studies conducted with novice and expert designers, we explored how PIC-UP might be used and the behaviors exhibited when deployed within a community of designers. We found PIC-UP may encourage sharing and reappropriating

features for storyboards, support design learning, tailor to both experienced and inexperienced users, and facilitate communication with others involved in design projects.

ACKNOWLEDGMENTS

This work was partially funded by the National Science Foundation (IIS-0851774). We thank the reviewers and ACs for their comments.

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