

StoryKit: Designing a Mobile Application for Story Creation By Children And Older Adults

Alexander J. Quinn¹, Benjamin B. Bederson¹, Elizabeth M. Bonsignore², Allison Druin²

University of Maryland

¹Department of Computer Science

²College of Information Studies

Human-Computer Interaction Lab

College Park, MD 20742 USA

Contact: aq@cs.umd.edu

ABSTRACT

As the capabilities of smartphones and similar mobile devices advance, opportunities increase to use them for meaningful creative tasks. Incorporating text, images, and sounds in documents is commonplace when using desktop office or graphics software. However, multimedia authoring interfaces for mobile devices remain undeveloped. Working with a participatory design group composed of children, older adults, and researchers, we developed StoryKit, an iPhone application for creating and sharing audio-visual stories on an iPhone. Our initial goal was to support children making stories together with older adults as a form of informal learning. To that end, it lets users create books on the touchscreen device by arranging their text, photos, drawings, and sounds on pages, and then sharing them via e-mail and the web. The design of StoryKit uncovered solutions to several general interface challenges that affect a wide range of mobile authoring applications. Thus, we think elements of the StoryKit interaction design may serve as a starting point for developers of mobile document authoring applications.

Author Keywords

Multimedia authoring, story telling, story authoring, participatory design, intergenerational design, mobile authoring.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Creativity continues to be an essential skill in the emerging creative economy [12]. Since scientific and technological creativity are tightly intertwined with cultural and artistic creativity [31], developing tools for creative expression can help all members of society [5]. Thus, ensuring open access to creativity-enabling technology is crucial for supporting social equality in the creative economy. With the global proliferation of mobile devices showing no boundaries, we are especially interested in creating mobile creative authoring tools. Storytelling is a creative activity that crosses all cultural boundaries.

Numerous research projects [e.g., 11, 16, 22, etc.] and commercial applications [26, 30, etc.] have sought to empower users to tell their stories anytime and anywhere, using mobile devices to incorporate the sights, sounds, and ideas encountered in their daily lives. Unfortunately, existing mobile applications lack the kind of content manipulation flexibility found on the desktop, thus limiting the degree to which users can mix and arrange their text, photographs, sounds, and other media to create more sophisticated representations of their ideas in the moment. Most research has been focused on social dynamics of collaboration and sharing [4, 11], the semantics of the composition process [22], or on novel presentation mediums [12]. Meanwhile, the need for stable, general user interface models for mobile authoring persists.

On the desktop side, interface models are well-established. When users want to create posters, booklets, slides, and collages, they have countless desktop applications to choose from. Each offers a slightly different way of manipulating the content, but most share basic commonalities that users have come to expect. Images and text are bounded by frames that are moved and resized by dragging from the



Figure 1. A child and her grandmother make a story together on an iPhone.

edges. A toolbar selects between tools that can be used to act on specific elements within the document. If a document contains multiple pages, they are arranged in a scrolling panel. These pages can be added, moved, or deleted via the application menu or a side panel, or by simply adding or deleting content at the end of the document.

We created StoryKit, a mobile application for story authoring that runs on the Apple iPhone. The design came out of a year-long participatory design process with an intergenerational group composed of children and older adults [9]. Besides creating the application, we wanted to develop solutions to some of the interface issues that currently challenge most other mobile multimedia authoring applications. StoryKit illustrates these solutions.

Initially, our goal was to find out if children, working together with older adults, could edit and create storybooks on mobile devices, and in the process, reap the educational benefits of such informal education experiences. In previous research, we had found that reading scanned children's books on the same device was indeed feasible [3] and that the text could be made readable in the smaller format by incorporating the ClearText method of resizing text within the context of a scanned book page [27]. With that as a starting point, we set out to design a new application interface to answer the current question.

Users create electronic storybooks with StoryKit by entering text, recording and attaching sounds, taking photographs, drawing illustrations on the device's touchscreen, or drawing pictures on paper and then photographing that. Users can also attach existing photographs from the device's built-in photo album, which in turn can easily be clipped from the web. In addition to creating new books, users can edit existing books, starting with scanned books from the International Children's Digital Library (www.childrenslibrary.com) [8] and changing it into a new story. The users' creations can be shared by uploading to a server and then sending a private web address to the story by e-mail directly from the phone. StoryKit can be downloaded from the iPhone app store by searching for "storykit" in the iPhone App Store.

The key contribution of this paper is not the StoryKit application itself, but rather the interaction design lessons learned in the process of building it. These lessons form design guidelines which are applicable to mobile applications for authoring a variety of content, including stories, photo collages, multimedia messages, presentation slides, cartoons, and other kinds of multipage documents. We present improved methods for:

- Arranging text and multimedia content on a canvas using a touchscreen,
- Creating rich electronic artifacts (i.e. stories, collages, slides, etc.) that are also viewed in the same application using some simpler viewing interface, and/or

- Sharing creations in a lightweight manner with consideration for users' privacy.

RELATED WORK

Many aspects of the prevailing interaction model for manipulating text boxes, image boxes, and other object based content can be traced to the document manipulation facilities of the Xerox Star. Dragging one part of a box or application window moves its location. Dragging the edge resizes it. However, just as Johnson points out in his retrospective view of the Star [17], ultimately the ability of the user to do work with the system is determined not by such coarse capabilities, but by thoughtful attention to the interface details and the way tasks are accomplished. Bulterman [4] surveys several paradigms for structuring content in multimedia authoring in general (presumably on a desktop computer), distinguished by the way the user relates the various multimedia objects (i.e. chronologically, spatially, hierarchically, etc.), which in turn determines the way the rest of the software guides the user to complete an authoring task. It was with the same spirit that we guided the design of StoryKit such that the operations necessary to edit or create a book and its constituent content are determined by the structure of the story.

Some research has focused on mobile authoring in specific modalities. For example, Koskinen discusses the range of uses of sound in mobile authoring, distinguishing between intentional and non-intentional sound recording (i.e. singing versus laughter) and also between foreground sounds and ambient sounds (i.e. speaking versus background music) [21]. Fröhlich has thoroughly study the space of audiophotographs, a fusion of plain printed photographs with audio recordings taken at the time of photography [15]. A field trial of an audiophotography prototype found that associating sounds with photographs synergistically enlivened both the sounds and the photographs, and also enhanced the memories associated with the events [14]. StoryKit also supports users to associate sounds with their stories. Context photography, proposed by Ljungblad, is an idea for augmenting photographs taken with cell phone cameras with data taken with motion and location sensors on the phone [23].

Mobile authoring and editing of video was studied by Wu, who found that users can reasonably edit video on a PDA device using the key frames and that users preferred location over time, as a way to refer to video segments [32]. They also explored the technical challenges of uploading video from a mobile device and developed an aggressive uploading algorithm to decide when and what to upload. In the case of StoryKit, we have similar technical challenges because the iPhone hardware is still not powerful enough to comfortably support real-time compression of the sound recordings. Thus, some users may end up waiting for a large WAV sound files to be transmitted over a slow cell carrier network if they share a story with a lot of sound where a faster Wi-Fi wireless connection is not available.

SandBoxes is a mobile application for creating collaborative collages of text, images, and sound [13]. Somewhat similar to StoryKit, it allows the juxtaposition of different kinds of media in one view. However, where StoryKit focuses on the challenges of creating substantial multi-page *books*, SandBoxes was more of an experiment in novel presentation of small single-page artifacts, such as might be sent by some future version of MMS. Also, its text facilities were designed primarily for adding short captions to photographs, rather than substantial storylines, thus avoiding some of the issues that this papers deals with.

Somewhat more similar to the work in this paper, the Mobile Multimedia Presentation Editor allows users to create comic strips, something akin to an illustrated storybook, containing photographs, sounds, and text [10]. However, their stories include a temporal element somewhat analogous to a PowerPoint presentation with automatic timing. Another key distinction, similar to SandBoxes, is that they were working with less sophisticated hardware with a smaller screen, specifically a 176×208-pixel (compared to the iPhone's 320×480-pixel screen) that does not support touchscreen interactions. Like this work, they endeavored to understand how users want to offer their creations and they focused on refinement of the interface, rather than more social or semantic aspects of storytelling, as many other projects do. They developed four design principles for mobile multimedia authoring, which were all guiding principles in the design of StoryKit: a) flexibility; b) awareness of the task context; c) expressiveness; and (d) personalization.

Mobile blogging, also akin to story authoring, was studied by Beale as a means to match the capabilities of smart phones with the practice of sharing photos and experiences on blogs with a streamlined interface [2]. StoryBank, another example of simplified mobile interfaces for storytelling, deployed cell phones with simplified story authoring software – a single photo and a single sound clip per page – to rural villages in India to record local folklore from residents, some of whom were unable to read or write.

Children's storytelling has long been an integral part of the storytelling literature. Madej provides a detailed account of the history of children's storytelling [24]. An early system example was Kim's Isis Story Builder, a desktop application which enabled children to create stories using electronic a building blocks, containing multimedia objects [20].

KidPad was a collaborative story authoring tool for children that ran on the desktop [10]. A key feature was that it enabled children to create nonlinear stories using zooming to transition between different contexts. The impact of this method was studied by Boltman, who found that spatial representations of stories helped children develop elaboration skills [4]. KidPad was also used by the KidStory project, which mixed various mediums to allow children to tell their stories. Cole showed how to enable copresent collaboration by displaying stories on an

overhead projector [5]. Later, the KidStory project enabled children to draw scenes from their story on PDAs and then upload them to the desktop for use in KidPad [29]. However, at that point, the collaboration was only supported on the desktop side.

Fails showed how to use mobile devices to enable children to read and create other stories collaboratively, with each child holding a separate device and the devices showing either a synchronized display or complementary displays (i.e. the left and right pages of a book) [11]. Although StoryKit was also designed with collaboration in mind, StoryKit still assumes that the users will create the stories together on one device, where Fails' work assumes separate, connected devices.

Some special-purpose devices have been developed with the sole goal of enabling users to tell their stories, without respect to authoring. Mäkelä studied how children prefer to communicate using digital photographs for fun and gave design recommendations, among them to enable children to create sets of images and annotate them with text and/or audio [25].

For adults, Balabanovi created a device to facilitate photo sharing, well before technology like the iPhone was widespread [1]. InStory was another early mobile example, but blended games, storytelling, and information access in a PDA device [6]. The iTell system was a desktop software application that endeavored to strengthen users' ability to tell stories retrospectively using digital photos [22]. Even larger, Shen described a design for a multiuser tabletop device for sharing photographs as part of personal storytelling [28].

DESIGN

StoryKit was designed by an intergenerational participatory design group composed of 6 children (ages 8 through 11), 6 older adults, and 6 researchers, including the authors. Over the course of one year, we met six times, including one field trial described later. In two sessions, only the children participated. Design sessions were held in a university research lab using the cooperative inquiry approach [10]. Because the iPhone is a cell phone requiring a service contract, about half of the devices used were iPhones and half were iPod Touch devices, which support the same software and touchscreen platform, but lack a camera, microphone, and speaker. Each iPod Touch was fitted with a snap-on speaker/microphone accessory. Illustrations using touch drawing were possible with all devices. One of the design sessions is shown in Figure 2.

In the first session, the participants tried other applications on the devices to develop an understanding of the iPhone interface paradigm. We also used the devices to read books using our reading application [9]. Having tried reading books on the device, we asked them how they would imagine creating books. The participants split into small groups and prepared sticky notes with their ideas. The



Figure 2. Our intergenerational design group worked in a lab to refine the design of StoryKit.

ideas ranged from very specific to imaginative and scientifically infeasible. We discussed the suggestions as a group and then put them on a whiteboard, grouping similar ideas together to cooperatively find some ideas that the group mostly agreed on. Finally, the participants split into small groups again and made sketches and low-tech prototypes of how they'd like to create stories. A typical example of the sketches they made is shown in Figure 3.

In subsequent sessions, they tried making stories using the latest version of the application. At each session, participants stretched the expressive capabilities of that version of the application and were engaged in making their stories. Several of the early versions had implementation bugs and the participants complained passionately if the bugs cause them to lose parts of their stories. At each session, they give us specific suggestions for the next round of fixes and new features. In most cases, they created low-tech prototypes to help us understand their ideas.

At times, we found that following a series of fine-grained suggestions led to an overall design that didn't fit the higher-level design vision of the group, so we rewrote sections of the code. The final session was held in a large park where the children and their older adult partners could spread out and make stories without interference from each other, using animals and other natural elements from the park world as inspiration or photographic subjects for their stories. Participants made elaborate stories consisting of many pages using photographs, drawings, sounds, and extended text narratives.

Because it was necessary to develop an entire application from scratch, we had to solve several significant design

challenges. The solutions came as the result of all parties – children, older adults, and researchers – using their respective strengths to come to the best design possible.

The impact of the children's advice was directly influential especially on the higher level choices of features, such as how to select colors in the paint mode, how to arrange content on the screen, and how to handle sound. The elders gave us very clear advice on issues such as how they wanted to enter text and how they wanted to share verbal stories using the sound recording. The researchers discussed all of the suggestions and ideas and then developed ways to realize them in code with the available technology. This included many of the lower level implementation details of the interface. We now describe the six primary lessons we learned.

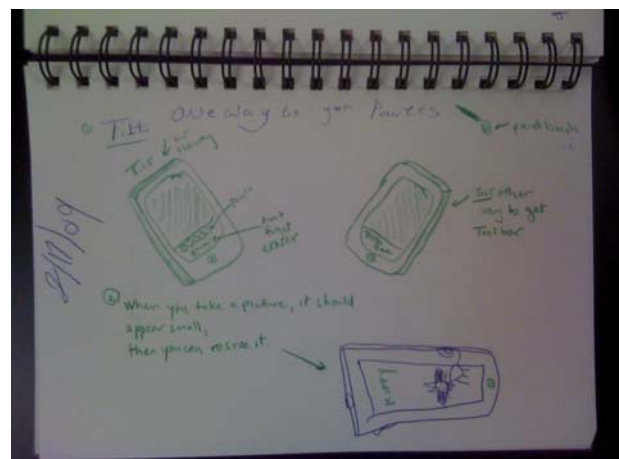


Figure 3. Description of a few interface ideas drawn by a child during one of the design sessions.

Design guideline #1: Resizing content

The iPhone uses a ubiquitous pinch gesture for adjusting zoom level of a canvas, such as a map or photograph. Treating each visual object as an individual canvas, it is natural to use the pinch gesture for resizing objects. Although this may seem nearly identical to dragging the edges of the frame on a desktop computer, if the user makes an object smaller than the area of two fingertips, it is not possible to enlarge the object in the same way. Therefore, we adopt a one-on-one-off pinch-resize strategy. If the user places one finger on any object, that object is selected and temporarily gets locked input focus. The other finger can be placed anywhere else on the screen to resize the selected object. When both fingers leave the screen, the object is deselected. The one-on-one-off pinch-drag gesture is illustrated in Figure 4.

Controlling the size and position of the object during the pinch gesture is also impractical given a naïve approach. It might seem intuitive to have the object track the fingertips such that the fingertips always remain in the same relative location within the box. However, implementing it in that way results in erratic changes in size and position. If the gap between the fingertips covers only a small proportion of the object, then moving them a small amount will resize the object as a whole by a large amount, resulting in an overly erratic user experience. For example, in Figure 5a, the fingertips cover $\frac{1}{4}$ the horizontal size of the object. With the naïve approach (Figure 5b), if the user did an expanding pinch gesture increasing the width of the gap between the fingertips by 30 pixels, the width of the object would increase by 120 pixels. Also, assuming the naïve approach, the overall position of the object would also change when the two fingers move, even if the user just wanted to resize. When movements are very small relative to the size of the fingertips, such fine control is difficult.

The compromise approach implemented in StoryKit (Figure 5c) is to adjust the size of the object by the same number of pixels that the two fingertips move (i.e. 30 pixels horizontally), without scaling to account for the fingertips' position relative to the object's bounds. Also, in this design, objects are only resized (not moved) when two fingers are in contact, and only moved (not resized) when one finger is in contact with the screen. The advantage of this approach is that the user has more fine control, even when resizing the object from the center. Also, this gives the user separate control for resizing and repositioning. The disadvantage is that the object does not perfectly track the fingertips, so it may feel unnatural to some users.

Design guideline #2: Attaching sound

There are numerous potential ways sound could be incorporated into a page of the storybook, but many possibilities are made impractical by inherent characteristics of the mobile device. If a single sound were associated with each page, then it would need to be long enough to accommodate as much sound or dialog as the user wanted to record. However, this would present a

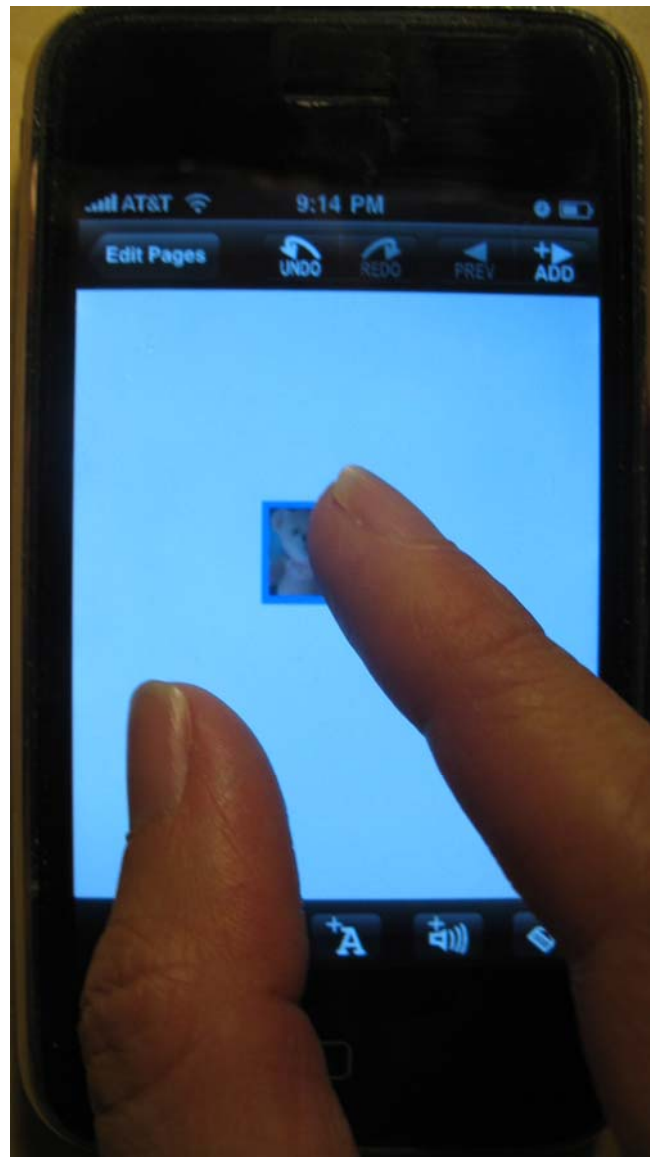
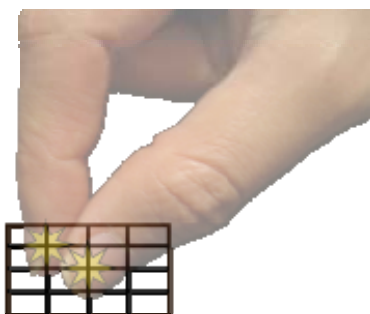
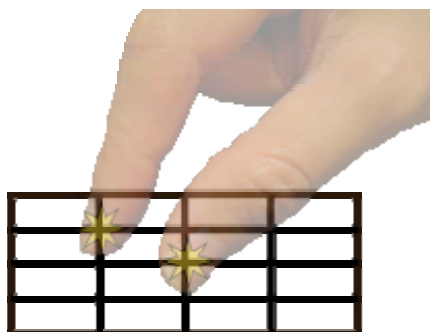


Figure 4. One-on-one-off pinch resizing allows users to resize objects that are too small to manipulate with both fingers at once.

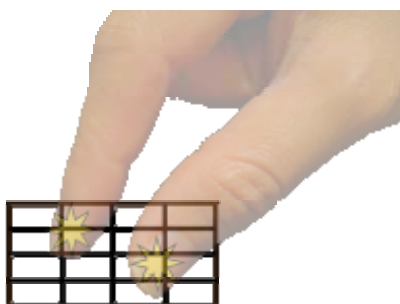
problem when designing undo and redo because there would be no clear feedback about what version of the sound was active. We also considered using a graphical waveform or a counter with the number of seconds in the time clip, but neither of these have any true semantic connection to the user's story so we would expect them to be confusing. Another problem with this naïve approach is that if the user turns on record and forgets to stop it, a very large file would be created, taking up limited space on the device and adding to the time required to transmit the stories contents to a server for sharing or archiving. Because of the device's limited CPU and the need to reduce overall CPU consumption in order to conserve the battery, the iPhone is not able to encode audio to MP3 or similar formats in real time, so all data must be saved and transmitted uncompressed.



(a) **Start state** (just before user does pinch gesture)



(b) **Naïve method (BAD)**. Object tracks fingers. Although fingers move by only a small distance, the object changes by $4\times$ *as much* because the fingers cover only $\frac{1}{4}$ of the box in each direction.



(c) **StoryKit method (GOOD)**. Total change in the object size is the same as the pinch gap change.

Figure 5. Comparing the StoryKit method of resizing with the naïve method. The yellow stars denote the effective point where the fingertips contact the touchscreen.

Our solution was to enable the user to create multiple sound clips for each page and move them around to associate them with elements in the illustration or text. Each clip is limited to one minute of recording, but an unlimited number of clips may be added to a page. To change or rerecord a sound clip, the user must delete the old sound clip and create a new one. Although this creates an extra step, it saves the ambiguity that would be associated with undo and redo operations of a sound edit. Since the sounds can be dragged over elements in the story, each version is automatically associated with something meaningful to the user. If the user does not reposition a sound, each

successive sound is initially positioned along the lower edge of the screen, and moving up as more sounds are added. For example, if the user creates a sound and then re-records it by deleting it (or undoing its addition) and creating a new sound, the new sound will appear in a different position so the user can still differentiate between the two versions using spatial memory.

Design guideline #3: Arbitrary amounts of text

We needed to allow the user to add any amount of text. If the design mimicked the expectations of desktop computers, the user might set a size for the text box and then enter the text directly into the text box. However, on a touch interface with only an on-screen physical keyboard, the keyboard occupies about half of the screen. For a large text box, it would be impossible to see the whole thing at full size while typing. Therefore, text entry must be done on a separate text editing screen, without regard to the size of the container. Thus, restricting the amount of text would amount to an opaque restriction. Furthermore, for the public domain books that are included with the StoryKit application, the text was decided by the author of the physical book. If the interface allowed users to enter text directly into the object on the page, then if the user entered a lot of text into a small text box, not all of the text could be visible.

This issue was solved by making all text boxes scrollable. When reading a story in StoryKit, if the text overflows the size of the container, it can be scrolled by flicking vertically on the text box. Stories shared on the web also enable scrolling when necessary using DHTML.

One drawback to this solution is that if the story is printed or converted to a static PDF file, the overflow text will not be visible. However, since such a presentation also does not support sound playback, this limitation is unavoidable for a mobile multimedia authoring application.

Design guideline #4: Smooth story creation flow

With a desktop application, a new text box or image might be placed in arbitrary locations on the page by the user. StoryKit was initially implemented like this. When children or adults created stories alone, they said they enjoyed the flexibility and the content in the stories they created was carefully arranged. However, we noticed that when they were working together, they were communicating more about text and images they wanted to put in the stories, but spent much less effort arranging things on the page. Having to position each element manually was an interruption and led to visually sloppy stories.

Because of the lack of similar mobile applications to compare with, we again considered how new content is positioned in desktop applications. In some, the user selects a tool from a toolbar (i.e. a new text box tool, etc.) and drags with a mouse in the content area to define the new text box's position. Dragging to select or draw new

rectangles is not a natural part of the interface model on this device, probably because unlike a mouse, which stops at the edge of the screen, a finger cannot easily start and stop a selection rectangle at the edges of the screen. Furthermore, with a touch-based interface, it is not possible to change the cursor shape to indicate that a special tool (mode) has been selected, so this would likely lead to confusion.

The solution we chose was to start with some default positioning rules that would look reasonable if left unchanged, but still leave the user the flexibility to reposition content as desired. In this case, given a blank page, a new text box is positioned in the lower half of the page and a new image is positioned in the upper half of the page. If there is already content in the default location for the new item, it is placed in the other half of the screen, unless that is also occupied. If both halves of the screen are occupied, a new photograph is allowed to overlap with a text box, since photographs are always positioned in a layer under text boxes. Since hidden defaults can potentially create an opaque mental model, this was among the most difficult design decisions. Although we considered giving the user a way to choose the default page layout, this would have added extra options and clutter to the application.

After making the change, the participants in the design group said that it was easier to mix different kinds of content. The stories they created after the design was changed were remarkably neater than before. However, one negative consequence of this policy is that it works best if photographs are square (aspect ratio of 1.0), rather than occupying the whole screen. Therefore, after taking a photograph, the application presents a screen where the photograph is cropped to be square and the user has an opportunity to pan or resize the portion of the original rectangular photograph that remains. Again, it might be possible to create a software option, but for a mobile application, simplicity takes priority over flexibility.

Design guideline #5: Reading mode

While creating a story, tapping most regions of the page results in an action to the page content (i.e. moving an image, taking a photograph, undo/redo, etc.). There are two buttons for moving backward and forward in the book. This density of hotspots is a necessity due to the small screen area, but this would be very distracting when reading a story that is finished or showing it to someone else. Thus, a separate reading mode is required. Initially, we had a button to switch between reading and editing mode on each page. During the discussions, the participants said they were often confused about which mode they were in. We discussed the issue with them, but ultimately addressing the issue required restructuring of the application flow.

The final version of StoryKit creates a deeper separation between reading and editing modes. After selecting a book, the user is presented with an option to read, edit, or share the book, along with a set of thumbnails for jumping to specific pages. To edit the book, the user taps Edit, and is

then presented with another screen from which pages can be added, rearranged, or deleted. From there, tapping on a specific page opens editing mode to that page. An advantage of this approach is that it puts facilities for adding, deleting, and rearranging pages close in the interface hierarchy to the screen for editing page content. A disadvantage is that switching from editing mode to reading mode requires some extra taps.

Design guideline #6: Sharing creations privately

When creating applications for children or others for whom privacy is a concern, requiring personal information to create an account and share the creations or use basic features should be avoided. This is especially important where a child's personally identifiable information may be included – which is likely in StoryKit since stories are likely to include pictures and sounds of the creators. Creating the account may be a significant burden for mobile users. For example, the user's usual place for storing passwords may not be convenient when using a mobile device away from home or the office.

We chose to keep extra overhead of sharing to an absolute minimum. When the user taps the Share button, there is a brief privacy notification (that their story will be sent to our servers), after which the story is synced with the server using a book key comprised of a combination of the device's unique identifier (not traceable to the user) and the book ID. When it is finished, the server returns a private URL for viewing the story and the application pops up a mail composition screen with which the user can e-mail that link directly to a recipient. The link is designed to be resistant to guessing and is not linked to anywhere. Therefore, the story can only be viewed on the web by someone who has received that e-mail from the user.

FIELD USE

As the final activity with the intergenerational design group, we used StoryKit at a historical national park that features a wide variety of farm animals and equipment to experience and stimulate stories. In addition to the usual design group members, five additional children and four additional older adults joined the activity. Two of the usual older adult design group members were absent so some of the children made their stories with graduate student researchers. Children worked in pairs with an adult while researchers observed and helped organize the activity. The ages of the group members ranged from 4 to 77 years old.

Throughout the day, all of the groups made meaningful stories and all participants contributed. The stories incorporated text narratives, photographs of animals (with iPhones), sound recordings of animals, and drawings. A typical example of the stories from that day is shown in Figure 7. In many cases, the children took photographs during active parts of the day (e.g. milking a cow) and then incorporated them into their stories later, together with their elder partners. In some cases, one would create illustrations or photographs while the other would enter the text of the



Figure 6. A child and his grandfather create a story together.

story, with no particular bias toward the child or older adult member doing one or the other.

The stories utilized the positioning of content to mix photos, drawings, text, and sounds to enhance the creative expression of the story. Some stories were narratives of the events of the day. Others were fictional compositions unrelated to the farm. Still others blended animals or elements from the park with imaginative ideas to create something new. Despite a hayride and a cow-milking experience, none of the devices were lost at the farm!

Near the end of the day, a researcher conducted semi-structured interviews with four of the elder participants. The responses expressed satisfaction with their experience with the device. When asked, "What feature or features did you like most about the StoryKit application?" responses included:

"The fact that it's all in one – the fact that you can do it all in one – it's a little publishing tool right there in your hand."

"I liked being able to put the images and the text together right away. That was important, the integrative function – we could get words and pictures right now on the page."

"The art/drawing tools and the recording – each is good I like both together."

However, although all groups used the positioning to create their stories, one older adult found it cumbersome, saying:

"We were having trouble moving and placing text...The process itself was very clear, but the doing of it was difficult."

Regarding the cooperative story authoring experience, one commented:

"It was a cooperative thing, There wasn't anything too hard for us to do together. I liked the fact that I remembered the "A" icon was for typing, and then [kid's

name] was able to remember how to use it, and then I could help him spell what he wanted to say."

Two challenges emerged through our use of the application. First, some children and older adults found the touchscreen software keyboard to be cumbersome. Comments included:

"My frustration was the small keypad, keyboard – it's a very seems difficult – [child partner] with her tiny fingers had no trouble at all."

"He [i.e., child partner] showed me how to type – I was not as fast because my hands are a little big..."

All were able to use it, but some expressed difficulty. The keyboard is a part of the device and cannot be changed by developers. Also, one of the older adults participants expressed frustration with the one-minute time limit imposed on sound clips, saying:

"A minute is a little short – but 2 minutes – it would be kind of fun to see what you would like to say in about 2 minutes."

CONCLUSION

Through this experience, we have demonstrated the capability to use an intergenerational participatory design group to develop mobile software for use by children and older adults. Furthermore, through the development of StoryKit, solutions emerged to interaction challenges that limit the expressive range of other applications.

Now is an exciting time to be developing mobile creativity-supporting applications because of the surge in adoption of convergence mobile devices that have the ability to support such uses. As the cost of the devices gradually comes down, we expect to see even broader adoption. Never before has a handheld served as a sufficient substitute for a desktop computer for so many different kinds of tasks.

Although creative authoring applications for mobile devices are blossoming, usability issues limit the scale of what users can create with them. As we have shown, often the most obvious design is not the best. With the StoryKit design and this rationale, we hope to lay a foundation that will aid those who are trying to push the creative limits of what can be done on handheld touchscreen devices by offering our interaction model as a starting point.

Having gained experience with the tool during the design sessions, we are now planning a case study to understand StoryKit can facilitate story creation and informal learning by children working with older adults in their environments. In addition, we plan to continue to refine the interaction details and perform controlled studies to compare our implementations with the naïve methods and with tools developed by others in the near future.

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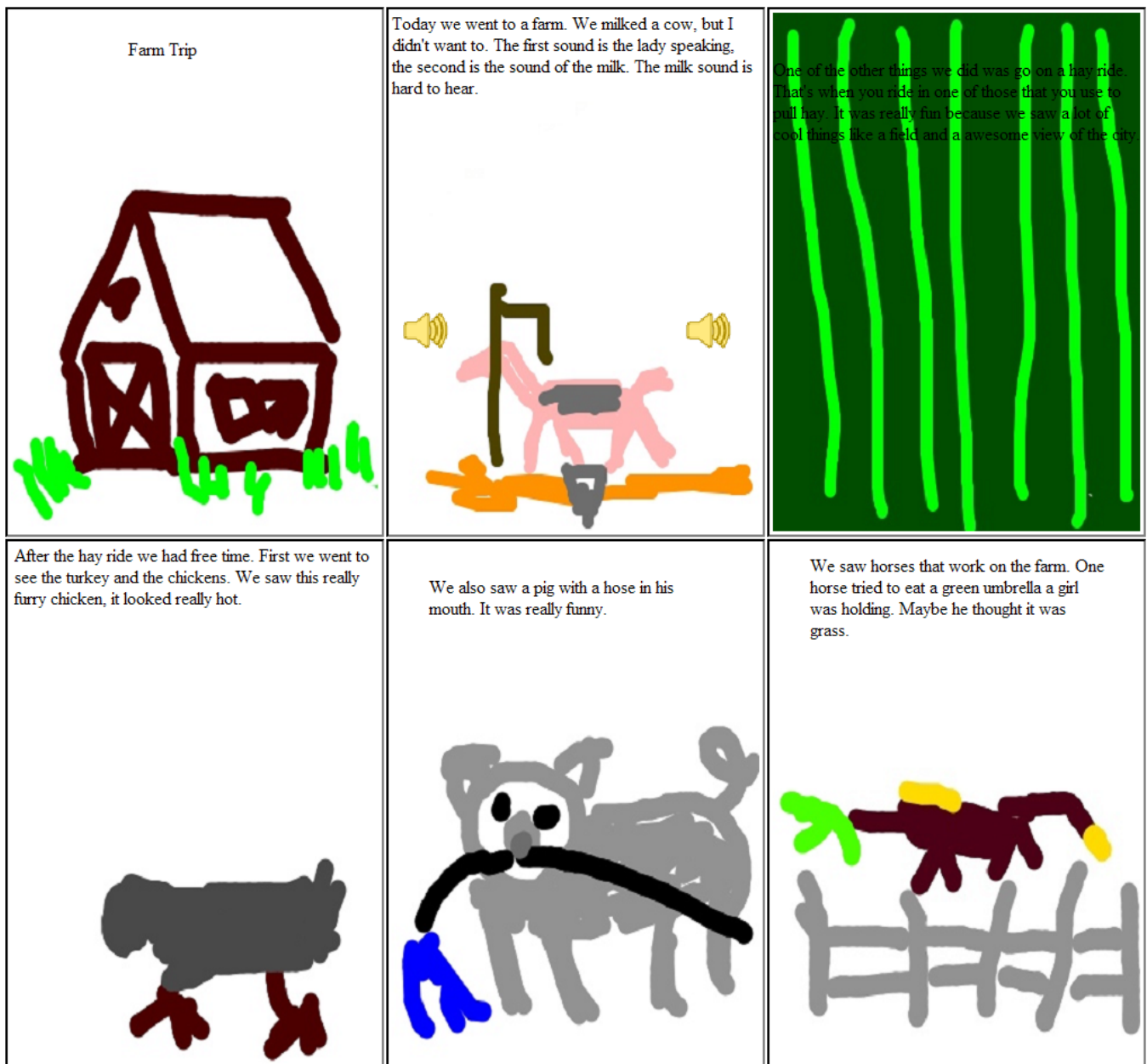


Figure 7. A story created during the field use at Oxon Hill Farm.

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REFERENCES

1. Balabanovi, M., Chu, L.L., and Wolff, G.J. Storytelling with digital photographs. *Proc. Of The SIGCHI Conf. On Human Factors In Comp. Systems*, ACM (2000), 564-571.
2. Beale, R. Mobile blogging: experiences of technologically inspired design. CHI '06 extended abstracts on Human factors in computing systems, ACM (2006), 225-230.
3. Bederson, B.B., Quinn, A., and Druin, A. Designing the reading experience for scanned multi-lingual picture books on mobile phones. *Proceedings of the 9th ACM/IEEE-CS joint conference on Digital libraries*, ACM (2009), 305-308.
4. Boltman, A. (October 2001). *Children's Storytelling Technologies: Differences in Elaboration and Recall*. (Ph.D. Dissertation, University of Maryland).
5. Cole, H. and Stanton, D. Designing mobile technologies to support co-present collaboration. *Personal and Ubiquitous Computing* 7, 6 (2003), 365-371.
6. Correia, N., Alves, L., Correia, H., et al. InStory: a system for mobile information access, storytelling and gaming activities in physical spaces. *Proceedings of the 2005 ACM SIGCHI International Conf. on Advances in computer entertainment technology*, ACM New York, NY, USA (2005), 102-109.

7. Druin, A. 1999. Cooperative inquiry: developing new technologies for children with children. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Pittsburgh, Pennsylvania, United States, May 15 - 20, 1999). CHI '99. ACM, New York, NY, 592-599.
8. Druin, A., Bederson, B., Hourcade, J., et al. Designing a digital library for young children: An intergenerational partnership. The craft of information visualization: readings and reflections , (2003), 178.
9. Druin, A., Bederson, B.B., and Quinn, A. Designing intergenerational mobile storytelling. Proceedings of the 8th International Conference on Interaction Design and Children, ACM New York, NY, USA (2009), 325-328.
10. Druin, A., Stewart, J., Proft, D., Bederson, B.B., Hollan, J.D (1997). KidPad: A Design Collaboration Between Children, Technologists, and Educators. In *Proc. of ACM Conf. on Human Factors in Comp. Systems* (CHI 1997), pp 463-470.
11. Fails, J. *Mobile Collaboration for Young Children*. (PhD dissertation, University of Maryland, 2009).
12. Florida, R. The rise of the creative class: and how it's transforming work, leisure, community and everyday life. Basic Books, 2004.
13. Fono, D. and Counts, S. Sandboxes: supporting social play through collaborative multimedia composition on mobile phones. Proc. of the 2006 20th anniversary conference on Computer supported cooperative work, ACM (2006), 163-166.
14. Frohlich, D. and Tallyn, E. Audiophotography: practice and prospects. Conference on Human Factors in Computing Systems, ACM New York, NY, USA (1999), 296-297.
15. Frohlich, D.A. *Bringing Photos to Life with Sounds*. London: Kluwer, 2004.
16. Frohlich, D.M., Rachovides, D., Riga, K., et al. StoryBank: mobile digital storytelling in a development context. *Proc. of the 27th Int'l Conf.on Human factors in computing systems*, ACM New York, NY, USA (2009), 1761-1770.
17. Johnson, J., Roberts, T.L., Verplank, W., et al. *The Xerox Star: A Retrospective*. Computer 22, 9 (1989), 11-26, 28-29.
18. Jokela, T., Lehtikoinen, J.T., and Korhonen, H. Mobile multimedia presentation editor: enabling creation of audio-visual stories on mobile devices. Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems, ACM (2008), 63-72.
19. Jones, M., Harwood, W., Buchanan, G., and Lalmas, M. StoryBank: an indian village community digital library. Proceedings of the 7th ACM/IEEE-CS joint conference on Digital libraries, ACM New York, NY, USA (2007), 257-258.
20. Kim, M.Y. Creative multimedia for children: Isis story builder. Conf. Comp. on Human Factors in Comp. Sys, ACM (1995).
21. Koskinen. Thinking About Sound in Mobile Multimedia, UBICOMP PICS Workshop, 2006.
22. Landry, B.M. and Guzdial, M. iTell: supporting retrospective storytelling with digital photos. Proc. of the 6th Conf. on Designing Interactive systems, ACM (2006), 160-168.
23. Ljungblad, S., Hakansson, M., Gaye, L., and Holmquist, L.E. Context photography: modifying the digital camera into a new creative tool. Conference on Human Factors in Computing Systems, ACM New York, NY, USA (2004), 1191-1194.
24. Madej, K. Towards digital narrative for children: from education to entertainment, a historical perspective. Computers in Entertainment (CIE) 1, 1 (2003), 12-12.
25. Mäkelä, A., Giller, V., Tscheligi, M., and Sefelin, R. Joking, storytelling, artsharing, expressing affection: a field trial of how children and their social network communicate with digital images in leisure time. Proc. Of The SIGCHI Conf. On Human Factors In Comp. Systems, ACM (2000), 548-555.
26. Nokia, LifeBlogs, <http://www.nokia.com/>.
27. Quinn, A.J., Hu, C., Arisaka, T., Rose, A., and Bederson, B.B. Readability of scanned books in digital libraries. Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems, ACM (2008), 705-714.
28. Shen, C., Lesh, N., Moghaddam, B., Beardsley, P., and Bardsley, R.S. Personal digital historian: user interface design. Conference on Human Factors in Computing Systems, ACM New York, NY, USA (2001), 29-30.
29. Stanton, D. and Neale, H. Designing mobile technologies to support collaboration. Personal and Ubiqu. Comp. 7, 6 (2003).
30. Whrrl. iPhone application in iTunes App Store. 9/2009.
31. United Nations (2008), Creative Economy Report 2008. The challenge of Assessing the Creative Economy: toward Informed Policy-making. Geneva 2008.
32. Wu, C., Teng, C.J., Chen, Y., Lin, T., Chu, H., and Hsu, J.Y. Point-of-capture archiving and editing of personal experiences from a mobile device. Personal Ubiquitous Comput. 11, 4 (2007), 235-249.