The NeverEndingStorytellingMachine: A Platform For Creative Collaboration Using a Sketchbook and Everyday Objects

Edwina Portocarrero, David Robert, Sean Follmer
MIT Media Laboratory
{edwina, sfollmer, lifeform} @media.mit.edu

Michelle Chung
Harvard Graduate School of Education
michelle_chung@mail.harvard.edu

ABSTRACT
TheNeverendingStorytellingMachine is a paper-based platform for story creation that allows asynchronous viewing and physical editing of shared media at a distance. The system incorporates analog and digital techniques as well as bi-directional capturing and sending of media, offering co-creation among peers whose expertise may not necessarily be in the same medium. A paper sketchbook serves as the primary interface, providing familiarity, portability and personalization. The interface maps pre-created digital media and newly captured analog content onto specific pages in the book through projection, permitting co-edition of the same page simultaneously or independently. Captured images are archived and displayed as a new layer over previous content on any other creation-station, collocated or at a distance. By gathering a history of the compositions, *TheNeverendingStorytellingMachine,* reveals narrative styles and strategies.

Author Keywords Paper Interface, Drawing, Storytelling, Collaboration, Tangible Interface.

ACM Classification Keywords H.5.1 Multimedia Information System.

General Terms Design, Human Factors.

INTRODUCTION
Stories become living agents, allowing us to learn about ourselves through others and about others through ourselves. Storytelling involves the use of our whole body, the exercising of our memory, the recollection of experience. A collective act, it requires a teller and a listener, roles exchanging as the story progresses; we make use of any expressive device to convey the message intended. As such, one particular media does not allow all users to express their vision equally. Some may prefer to capture and share their experiences or imagination through drawing, while others may be more inclined towards the written word, audio, music or collage.

TheNeverendingStorytellingMachine, is a graphical, audio-visual and language interface that invites storytellers of any age to experience, create, share and edit each other's work either in a linear narrative or free-style form, making use of any and every medium they feel comfortable with. By allowing any object to become material for creation, through the use of camera capture, we propose that everything is embedded with expressive potential and hope to incite exploration of our immediate surroundings.

UbiComp'10, September 26–29, 2010, Copenhagen, Denmark.
ACM 978-1-60558-843-8/10/09.

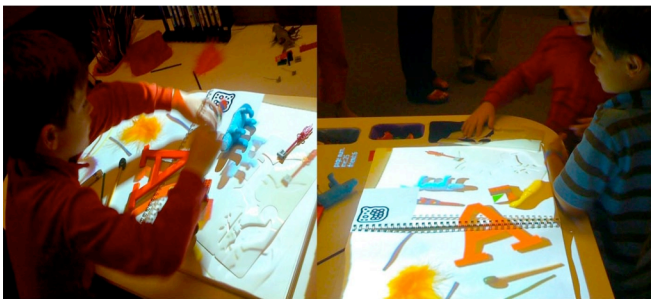

Figure 1. The boy on the left puts down a red, letter "A" block in his sketchbook and snaps a picture, sending the image to be projected onto his friend's sketchbook. The two boys view the resulting image together on the right.

The book format interface, through the use of a regular paper sketchbook, provides a flexible system by allowing a narrative to be developed and revisited. Having a page number and marker as reference gives users the option to work either simultaneously and in the same page or asynchronously.

Intended to be a platform for creative collaborative endeavor, *TheNeverendingStorytellingMachine* is nonetheless further maximized when used as a presentation system – where the input interface and final product are the same. Our goal is that users are compelled to see all the content that has been created prior to them, and build off of this, creating stories with others through different media.

RELATED WORK
Our work is motivated and inspired by a number of projects from the realm of CSCW. Kidpad allows for children to collaboratively draw stories together using on onscreen zoomable interface [6]. Nonetheless we are more interested in how we can allow users to bring in physical media across a distance. Clearboard allows users to draw on a shared surface at a distance while maintaining the ability to reveal each other's gaze and other gestural interactions [7].

However because of its vertical slant and real time capture system, it does not allow for the use of other media such as objects or paint, only drawing. VideoDraw and Double Digital Desk both allow for two remote users to share objects and sketches on two remote physical tables with the use of camera and projectors [11, 12]. Similarly, Sharetable applies this paradigm for remote collaboration between parents and children [13]. However these examples do not have "memory," they only display what is currently on the other side – you cannot easily copy objects or drawings to keep them on screen. Our system also introduces the book metaphor as a way to have more spatially multiplexed content. Also, our focus on asynchronous capture can provide for more artistic content to be produced.

We also draw on work from the field of tangible and augmented interfaces for children. Jabberstamp allows for children to add audio to specific locations in drawings, however it is not shared across a distance and only allows for drawings as input – not objects [8]. Similarly, Stifelman's work allows users to add audio to any physical document [10]. Our system permits audio input, but only on a page-by-page basis. IO brush explores how we can use objects in the real world as a pallet from which to paint with [9]. However we focus more on compositions and an augmented form of college, than augmenting the paint itself.

THE NEVERENDINGSTORYTELLINGMACHINE SYSTEM

TheNeverendingStorytellingMachine is a system to create and edit a visual and audio narrative in book form at a distance, making use of any type of media, digital or analog, over a paper sketchbook interface. Users can embed voices and soundtracks to their stories, draw over spoken narrative or collage digital and analog content. *TheNeverendingStorytellingMachine* is also a display and communication platform.

Figure 2. Two children experiment on collocated "creation-stations" by sending images back and forth via overhead webcams and projectors.

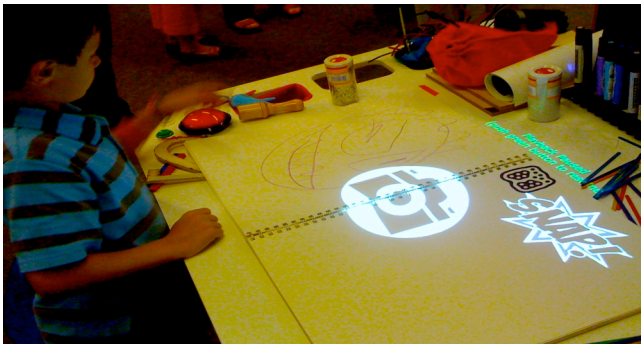

Figure 3. Child presses the red "capture" button to save and send a snapshot of his drawing to other creation-stations, corresponding to the correct page with the same Fiducial marker.

The system consists of two networked "creation-stations" that could be connected together through the Internet at any location. These creation-stations have a camera and projector system to capture and display content at scale. A large red button allows for capturing images of physical objects, or drawings, into the current page of a sketchbook. These pages are synchronized between the stations, i.e. what is captured in one book on page one is displayed in page one of the synchronized book. This allows users to build compositions together at a distance. Flipping pages will change the projected content to match the current page. The interface also displays the current page of the other user.

Since the system uses a physical paper sketchbook as the interface, the graphical and written content could be created anywhere, and captured later, making it a familiar, accessible tool to anyone anywhere. Once the sketchbook is brought into a "creation-station", it is transformed into shareable, enhanced media.

TECHNOLOGY

TheNeverendingStorytellingMachine works through the integration of a projector-camera system, a paper sketchbook with Fiducial markers, custom made software to capture and layer content and four buttons attached to an Arduino board: capture, send, record and pause. The custom made software is written in Touch, a visual programming environment [1, 2]. The Arduino was configured to listen for physical button presses and communicate their activity via serial protocol to Touch. Live video input from the webcam is run through a homography process, extracting corner-pin coordinates and re-projecting them to fit the sketchbook. A secondary camera uses the ReacTIVision [15] system to detect Fiducial Markers placed on each book page spread. The final resulting video projection sent from Touch is a composite image formed by the pre-made, background content (unique per book page spread) as well as the latest camera snapshots from both (or all participating) creation-stations.

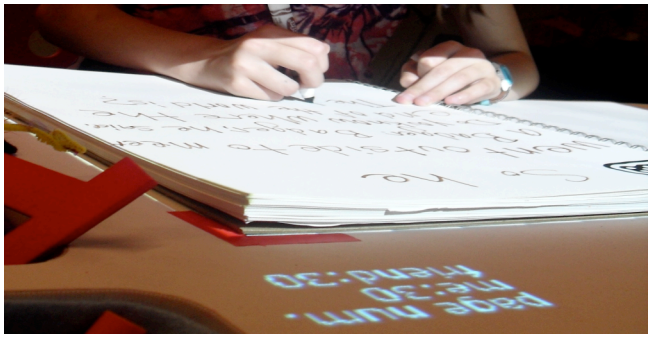

Figure 4. The creation station displays the page number of the current user and any other networked participants.

The creation-stations are networked to each other and access each other's file systems to read images and sounds. Additionally, metadata is sent over the network to inform each participating creation-station of each other's current page. Finally, video can be optionally broadcast over the network to enable a viewing station to watch the content evolving organically. All of the applications are built in a scalable, modular structure to support the expansion of the project based on site-specific needs.

DISCUSSION

Immersive Storytelling

Engaged by both physical and digital dimensions, users are no longer constrained by traditional story writing means, but instead, are encouraged to explore stories as multi-sensorial experiences.

A seamless hybridization of analog and digital modalities including visual, audio, and tactile elements, make *TheNeverendingStorytellingMachine* a powerful tool for communication. Allowing the user to bring their own personal objects, voices and ideas to the storytelling stage, *TheNeverendingStorytellingMachine* blends the edges of the conventional book with the outside world, offering limitless material for potential inspiration to produce meaningful narratives. Multiple entry points and multimedia resources invite users to immerse themselves in the creative process regardless of age or creative expertise.

Cooperative Authorship

TheNeverendingStorytellingMachine investigates new modes for content creation that folds author, viewer, and editor into one role shared by multiple users. Stories are treated as evolutionary collages with open participation. With the possibility of saving editions of the story in real-time, *TheNeverendingStorytellingMachine* could offer a type of hybrid library, where stories are archived in both digital and analog form and where authorship is seen as a social collective [5]. Documenting the evolution of content over time could also act as evidence to reveal narrative styles and strategies or to research co-creative processes.

Distance Collaboration

As a portable, self-contained system, creation-stations can be installed locally or installed over distances. This means that users could be in two different places, but synchronized to work on the same content. *TheNeverendingStorytellingMachine* could thus be an important informal and formal learning instrument as users in one location create stories together with users of different countries, cultures, or backgrounds. *TheNeverendingStorytellingMachine* in classrooms could help teachers expose students to stories from around the world, while teaching formal literacy skills and building empathy, drawing upon constructivism and collaborative pedagogies [3, 4]. Installed in museums and public spaces, the system could exhibit various stories from the public, gather a single, collective memory across time and space, or be used in performance art. In the home, family members could play and tell stories with loved ones far away or work autonomously on personal compositions.

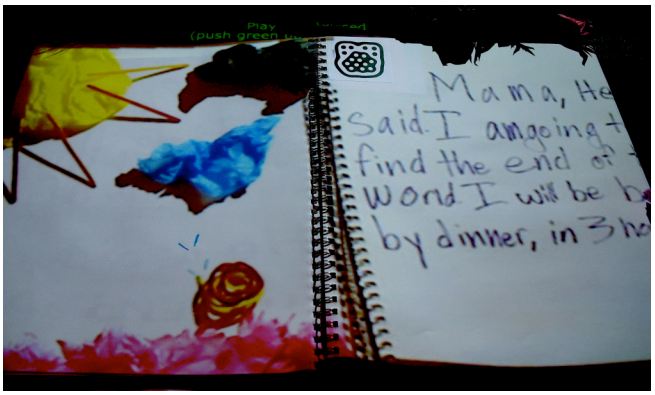

Figure 5. Mixed media content for one story co-created over time by multiple users in different locations.

FUTURE WORK

Based on observation, users engaged in their work using both hands, especially when holding down and object or stamping body parts, making it difficult to press the "send button", usually resorting to their elbow. We plan to add a pedal button, so that the user can make full use of both hands and instead use the foot if chosen so.

In order to take full advantage of the accessibility of using a paper sketchbook interface, we plan to implement d-touch [14] markers. This have the advantage of being designable, convey meaning and being easily produced by the user without the need of a computer, printing and adding. By following a set of simple rules, the user can use any medium that provides high contrast to create them. Thus the user could draw personalized markers that seamlessly integrate to their creation.

REFERENCES

1. Arduino. www.arduino.cc
2. Touch. www.derivative.ca
3. Dewey, John. Experience and Education. New York, Touchstone, 1983.
4. Papert, S. *Mindstorms*. New York: Basic Books. 1980
5. Jenkins, Henry. (2006). Confronting the Challenges of Participatory Culture: Media Education for the 21st Century. Cambridge, MA: John D. And Catherine MacArthor Foundation. Retrieved from www.macfound.com
6. Hourcade, J. P., Bederson, B. B., Druin, A., and Taxé G. 2002. KidPad: collaborative storytelling for children. *Proc CHI 2002*.
7. Ishii, H. and Kobayashi, M. 1992. ClearBoard: a seamless medium for shared drawing and conversation with eye contact. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (1992). P. Bauersfeld, J. Bennett, and G. Lynch, Eds. CHI '92. ACM, New York, NY, 525-532.
8. Raffle, H., Vaucelle, C., Wang, R., and Ishii, H. 2007. Jabberstamp: embedding sound and voice in traditional drawings. ACM *SIGGRAPH 2007*.
9. Ryokai, K., Marti, S., and Ishii, H. 2004. I/O brush: drawing with everyday objects as ink. *Proc. SIGCHI Conference on Human Factors in Computing Systems* 2004.
10. Stifelman, L. J. Augmenting real-world objects: a paper-based audio notebook. *Proc.* CHI 1996.
11. Tang, J. C. and Minneman, S. L. 1990. VideoDraw: a video interface for collaborative drawing. *Proc. SIGCHI Conference on Human Factors in Computing Systems: Empowering People* 1990.
12. Wellner, P. and S. Freeman, The DoubleDigitalDesk:Shared Editing of Paper Documents. Technical Report EPC-93-108, EuroPARC 1993.
13. Yarosh, S., Cuzzort, S., Mueller, H., and Abowd, G.D. Developing a Media Space for Remote Synchronous Parent-Child Interaction. *Proc. IDC*, ACM 2009.
14. d-touch. www.d-touch.org
15. ReacTIVision. www.reactivision.sourceforge.net