Towards Preserving Indigenous Oral Stories Using Tangible Objects

Andrew Smith[1] Lizette Reitsma[2] Elise van den Hoven[2] Paula Kotzé[1,3] Louis Coetzee[1]

[1] CSIR Meraka Institute
Pretoria, South Africa

{acsmith,pkotze1,lcoetze1}
@csir.co.za

[2] Eindhoven University of Technology
Eindhoven, The Netherlands
e.v.d.Hoven@tue.nl

[3] IICTA, Nelson Mandela Metropolitan University
Port Elizabeth, South Africa

Abstract—**Handcrafted beadwork produced by the BaNtwane people of South Africa is loaded with meaning. Communicating indigenous oral stories is important for passing on culture-specific traditions and community memory, such as the meaning of the handcrafted beadwork. Oral stories are told within the physical confines of the community. The community we focus on in this paper suffers from younger generations moving away physically, start preferring the English language over their mother tongue and digital over oral communication, and therefore this co-located storytelling process is interrupted. As part of the StoryBeads project we have created an interactive system that incorporates a combination of physical objects and modern technology for recording and replaying oral stories that can help preserve the meaning of the handcrafted beadwork of the BaNtwane people.**

Keywords-storytelling; culture preservation; tangible object

I. INTRODUCTION

Harms [1] infers that the lack of written African information is problematic when academics wish to create Western writings of African history. In Africa the oral narrative in combination with 'intangible props', such as dance and conventions [2], are used as a mechanism for communicating community memory through personal life stories. An example of an oral narrative loved by the Manyika, of the eastern highlands of Zimbabwe in Southern Africa, relates to a fictitious person called *Nzuzu* [3]. Nzuzu is a beautiful woman who lures men to her watery home and drags them to the bottom, only to be released after many days if they fulfil her wishes. Some details of this story often reflect the teller's own view of life and are always told in a quiet voice. One of the limitations of this mechanism is that issues immediately relevant to the current generation tend to be the only oral narratives reflected or preserved [1].

According to Scheub [4] the advantages of the oral narrative are that it allows (a) the use of expressions that are difficult or impossible to capture in written form, and (b) the adaptation of metaphors in the story over time, keeping the narrative relevant for the local community and up-to-date. In Africa where the oral narrative is the innate method to preserve knowledge, the oral narrative potentially captures more metaphors than would be the case with a written form. Recorded oral narratives have the benefit of providing future researchers access to the stories along with the metaphors used at the time of the recording. Indeed, Tomaselli [5] uses the metaphor of a prison when describing written text, alluding to the many limitations placed on this form of communication. Capturing oral narratives in a form other than writing could therefore be useful in preserving African history.

Our goal was to develop a mechanism for preserving the meaning that the BaNtwane people attach to their beadwork. We focused on the following two critical properties of such a system: (a) the system interface, as exposed to the storyteller and audience, must fit in well with the local culture and story-telling traditions, and (b) the system should allow an audience not physically present when the story was told access to the captured narratives.

Section II discusses the preservation of cultural heritage through storytelling, various communication modalities, the BaNtwane people of South Africa, and the StoryBeads research project in general. Section III describes the research method followed, while Section IV gives an overview of the system, its functions, the user interface design, and the embedded technology. Section V describes the operation of the system. Section VI discusses our initial findings. Section VII discusses proposed future work, and section VIII concludes.

II. BACKGROUND

In this section we discuss the preservation of cultural heritage through storytelling, various communication modalities, the BaNtwane people of South Africa, and the StoryBeads research project in general.

A. Preserving Cultural Heritage Through Storytelling

For cultural heritage preservation it is important that history is recorded. In Western cultures this is generally achieved by the 'written' word, whilst the oral narrative is the primary communication mechanism used in African cultures to preserve information for the future [6]. 'Recording' in the traditional African context is done through individuals' memories of the stories told. This may lead to loss of information when the chain of narration stops for some or other reason. One such reason is the current trend of the younger generations of the community to move away because of education or work opportunities elsewhere. The chain of oral indigenous knowledge preservation (in the memory of the storyteller when in the absence of a listener)

978-0-7695-4546-2/11 $26.00 © 2011 IEEE
DOI 10.1109/Culture-Computing.2011.24

is therefore broken and there are no other mechanisms available, or used, to record this traditional African knowledge. This causes a serious problem that might lead to the loss of traditional knowledge. There is thus a need to explore culturally fitting recording mechanisms to assist in preserving such African culture. According to Bidwell [7] the African oral traditions, as conveyed by means of speech, warrant close attention and is currently the focus of much research.

B. *Communication Modalities*

Combinations of communication modalities (for example, speech and photos) have been used in previous research [7]. An example of such a combination is the StoryBank project [8] that used camera-equipped mobile phones to facilitate audiovisual story creation and sharing. Oral narratives have also been combined with works of art to create recontextualized narratives [9]. Other communication modalities such as gesture, song, music, drama, rituals, skills, and crafts could also be considered as culture preservation mechanisms [2]. Developed-world storytelling applications seem to focus on printed text, photo and video as the medium [2, 10-14], while for the developing world this might not be the medium that is most suitable.

We limited the StoryBeads project to the traditional oral storytelling modality and the research focus was on the design of a user interface, which appears as an extension of an everyday object.

C. *The BaNtwane People of South Africa*

The StoryBeads project focused on storytelling as a means to communicate cultural heritage of the BaNtwane people, found in a tiny area in the north-eastern part of South Africa [15]. The BaNtwane people are located in a semi-rural area where running water and electricity is considered a luxury. In this geographical region traditions are strong and integrated into daily activities.

D. *Tangible Objects*

A technology that is fast gaining recognition as alternative input modality for applications, which does not require textual input, is that of tangible interfaces. Tangible interfaces allow users to manipulate objects that provide input to a computing device, e.g. through the use of electronic tags [16]. Examples of electronic tag technologies are Radio Frequency Identification (RFID) [17] and Quick Response (QR) codes [18].

When designing for culturally sensitive interaction, care should be taken with the design of the physical object that will act as an interface between the user and the computing device that holds the electronic representation of that object.

Creating tangible interaction using personal objects can benefit from the existing mental models users already have of the object and the related story [19], as for example implemented in the Digital PhotoBrowser [20, 21] and Souvenirs system [22].

The Tangible Viewpoints system [23] and the 3D story cube [24] applications are quite dissimilar to the topic of this paper, but they do show the flexibility in tangible interaction opportunities in storytelling. In these projects the tangible artefacts as well as the stories are newly designed by the developers, while in StoryBeads we wanted to use existing objects and existing stories to allow the community members to interact with the information in a manner which fits their culture. Therefore it may be relevant to look into the field of tangible interaction and how physical objects are used in storytelling systems. For example, the Tangible Viewpoints system uses physical pawns on a digital tabletop for selecting perspectives within a story which are then displayed. The 3D story cube, as another example, uses physical cubes as an augmented reality interface in a book.

As an alternative to the design and creation of a new physical object, the repurposing of an object that already exists in the local community may be considered instead. In either case it would be wise to consult the community in order to establish which objects would be appropriate, what colours are suitable, and a myriad of other considerations [25]. This may seem trivial to researchers from developed regions, but in African cultures these dimensions are often loaded with meaning and cannot be ignored.

E. *The SoryBeads Project*

Tangible objects could potentially serve as an alternative communication mechanism to the recording and preservation of traditional African heritage, and it is therefore worthwhile to investigate whether this is feasible and what could be learned from such an endeavour.

The BaNtwane people use physical objects, such as beads, in self-made dedicated jewellery (Fig. 1) as cues and physical representations for these stories, and we decided to make use of these familiar objects in designing an appropriate interaction device for the community; for this reason the name ‘StoryBeads’ was adopted to describe our research project.

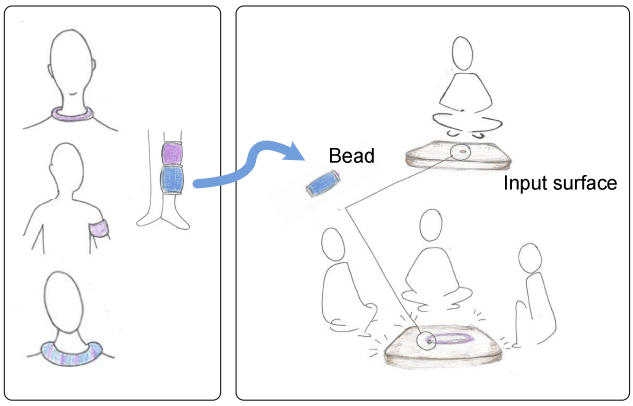

Figure 1. Beads have meanings attached to them.

III. RESEARCH METHOD

Our research commenced with a brief study of beadwork found in South Africa [26]. The preservation concept was additionally informed by existing literature ([2, 27], for example). The design concept for preserving the meaning of beadwork that emerged relied on a recording mechanism that

should be aligned with the cultural customs and ideas of the targeted group, in our case the BaNtwane people [15]. The preservation concept was proposed to the BaNtwane people to verify its relevance. From our discussions with the BaNtwane people we concluded that our proposal was indeed relevant as younger members of the community had less-than-ideal knowledge of the meaning of the beadwork created, and used, by their community.

Previous research done on the use of African artefacts that serve as technology interfaces informed the approach we followed in designing the user interface. Dimensions we specifically considered are (a) the abstractness of the artefact [28] and how this is interpreted by the BaNtwane people, (b) the use of tangible objects in the African context, ensuring that the artefact is appropriate for the geographical and social region under consideration, (c) messages that may be 'hidden' in the artefact, and (d) sensitivity to the BaNtwane people's reaction when a new artefact is introduced to their community [25].

Two design options were presented at the first discussions held with the BaNtwane people. The aim of these discussions was to gain a thorough understanding of the BaNtwane beadwork itself and the customs relating to the beadwork.

Outcomes of these discussions were synthesized and translated during an ideation phase into a concept evaluator that could record, recall, and delete a story by using an eBead design. This concept evaluator was evaluated during a second visit.

In order to maximize the results to be obtained from the second visit, and to gain an understanding of the cultural aspects that had to be kept in mind during an evaluation that involved the BaNtwane people, several discussions were held with Nicola Bidwell on how to approach such an evaluation. The result of these discussions was a two stage evaluation plan. First, the community member was shown the eBead design and asked to comment on it. Second, the concept evaluator was presented to the community member, who was given an opportunity to use it and to comment on the design.

IV. System Overview

Our aim was to create a physical mobile device with which the BaNtwane people could record and 'store' stories in hand-made beads and later use the same mobile device to play back these stories. Such a system could be used where there is an increased tendency for community members to live further apart and no longer participate in many storytelling events.

The StoryBeads system consists of the StoryTeller and a collection of eBeads (Fig. 2). An eBead consists of a handmade bead and an embedded RFID capsule (Fig. 3). The StoryTeller consists of a laptop computer, a microphone, a loudspeaker, and an RFID reader. The enclosure which encapsulates all the components of the StoryTeller is called the Input Surface (Fig. 4).

A. StoryBeads Functions

The physical user interface consists of an eBead and the Input Surface. When an 'empty' eBead (an eBead without an associated story) is placed on the Input Surface, a pre-recorded audio prompt invites the user to tell a story about the meaning of the beadwork of which the eBead is a part. When this eBead is removed from the Input Surface, the story that has just been told is associated with the eBead. The recording is played back when the same eBead is again placed on the Input Surface. The story can be erased if the user is not satisfied with the story. A new story can then be recorded and associated with this eBead.

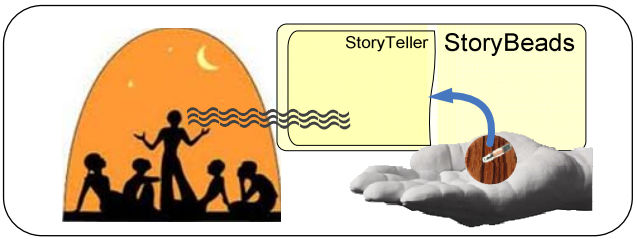

Figure 2. The StoryBeads system consists of the StoryTeller and a collection of eBeads.

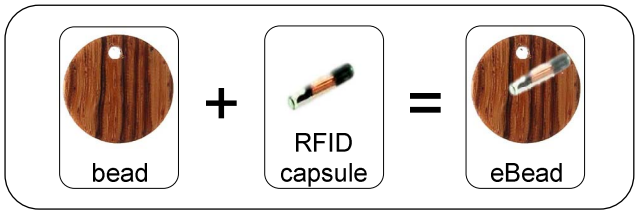

Figure 3. An 'eBead' is the combination of a handmade bead and an RFID capsule.

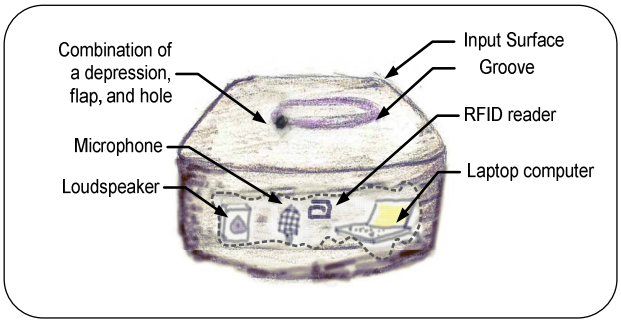

Figure 4. The Input Surface 'hides' the modern technology by enclosing it.

Two technologies were important to the successful completion of our research project. These are (a) the tangible user interface with which the person telling the story interacts, and (b) the embedded technology. These technologies are discussed next.

B. The Tangible User Interface

Knowledge of the target group, the BaNtwane people, was the primary consideration in the design of the user interface. In order to limit the influence our research might have on the BaNtwane people, we based the user interface on materials and operations that are already familiar to them.

In keeping to our objective of minimal interference, we embedded all electronic technology inside hand-crafted objects. The BaNtwane people interacted with, and manipulated, only these handcrafted objects. The input surface is rectangular with a circular groove (Fig. 4). We created a depression at one spot in this groove. This design provides a strong affordance [29] of a necklace to be placed in the groove, and the eBead to lie inside the depression.

C. *The Embedded Technology*

Identification, recording/playback, and storage are three functions that should be considered when capturing oral stories. 'Identification', determines which eBead to associate with a story. An RFID tag, embedded inside a handcrafted bead, is used for this purpose (Fig. 5, right). 'Recording/playback' captures the audio from the person telling a story with the aid of a microphone (Fig. 5, top left), and reproduces audio with the aid of a loudspeaker (Fig. 5, bottom left). 'Storage', saves and retrieves the stories on the embedded computer's hard disk drive (Fig. 5, center).

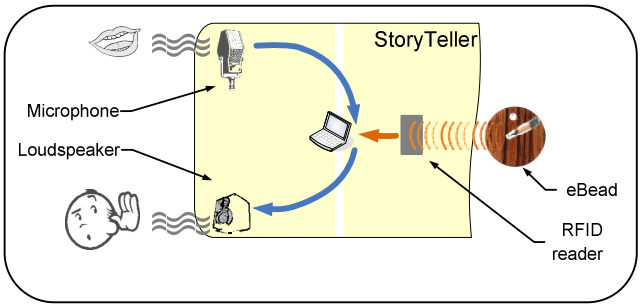

Figure 5. The StoryTeller.

V. System Operation

In this section we discuss the operation of the StoryBeads system.

A. *Recording and Playing Back a Story*

When an eBead is placed in the depression, the eBead's unique identification number is read and sent to the computer. The computer responds in one of three ways. First, if a story has already been associated with the tag the story is retrieved from the hard disk drive and the audio played through the loudspeaker. Second, if no association has previously been established, the user is prompted to tell a story which will be recoded. Third, a story associated with the eBead may be deleted.

B. *Deleting a Story*

A story can be deleted by passing the eBead through a hole (Fig. 4) in the Input Surface specifically created for this purpose. As the eBead exists from the hole the recorded story is erased from the computer hard disk drive and the eBead is no longer associated with a story. At this stage the eBead is 'empty' and a new story can be recorded and associated with the eBead.

Accidental deletion could have serious consequences and we therefore devised a three-step action sequence to prevent accidental deletion. First, the user has to release a mechanical latch embedded into the depression where the eBead usually lays. Second, a flap covering a hole in this position is opened using two fingers. The StoryTeller repeatedly plays back a pre-recorded verbal warning message while the flap is lifted. Third, to complete the deletion action, the user places the eBead into the hole. At this time the warning message changes to an informing message, confirming that the story has been deleted. The user now closes the flap and secures the latch, and the voice prompt ends. The StoryTeller is now ready to react to the next eBead placed in the depression.

VI. Findings

Our evaluations with the BaNtwane people revealed four dimensions of importance. These are:

- The need to preserve the heritage: During the interviews a community member indicated that there was a need to preserve their cultural heritage. The community member suggested that a database would fulfil this need. In addition, the community member indicated that our evaluation video recordings may serve as an additional medium in preserving the meaning of the BaNtwane beadwork.
- The value that lies in all stories: A community member explained at length that there was no need to delete a story once it had been recorded. The explanation given was that all stories have value and deleting a story would constitute 'throwing away' valuable information.
- Appropriate interface that fits the BaNtwane people's conversation style: The concept evaluator contained an oral interface. Using this interface, the system informed the user of the options available. We evaluated both concise and verbose oral messages. During the evaluation the community member was invited to indicate which version was preferred and provide a justification. It transpired that the verbose version was preferred because the user felt more comfortable about what was expected from him. This can possibly be explained when considering the similarities the verbose sound clips have with the cultural dependent way of communicating, which is also verbose.
- The significance of colour in the BaNtwane culture: During our initial interaction with the BaNtwane people we were shown a large variety of beads of various colours. Based on our observations, we chose the colours yellow, blue, and green for the eBeads. At the evaluation it transpired that the BaNtwane had already associated these colours with other African cultures. The participant informed us that a BaNtwane community member might have these colours incorporated into beadwork apparel to signify lineage, but the colours are however not appropriate for incorporation in a system targeted at

the BaNtwane people. It can thus be concluded that colour should be dealt with care and that the meaning of each colour should be determined before being used.

VII. Future Work

From our observations several design requirements arose for consideration in future designs. These will be discussed in a future paper.

The StoryBeads project also illustrated that it is technically possible to construct a self-contained unit that can record oral stories and play the stories back by using a combination of handcrafted objects and modern technology.

Our next objective is to make these recorded stories available through the Internet. What follows is a description how this could be done by integrating StoryBeads with the Internet of Things.

Information and communication technologies are rapidly advancing and impacting many societies. The ways people are interacting, how they expand their circle of friends and how they share information within this circle of friends are continuously changing. The advances in technology, the increased electronic connectivity and the creation of innovative applications such as Facebook [30] are forever changing the face of society. Broadband connectivity is becoming affordable, and ubiquitous [31] devices now have increased processing abilities. Embedded sensors and actuators are now reduced in size with increased abilities. Advances in such connectivity, processing capabilities, and sensor/actuators means that such are increasingly also connected to the Internet. These connected devices have the ability to communicate their sensed data to 'smart' services and act on commands received from these services at 'any-time', at 'any-place' and with 'any-thing'. This phenomenon is known as the 'Internet of Things' (IoT) [32] (Fig. 6). The vision of the IoT society is to connect billions of 'Things', many of them able to act and influence their surroundings, and the masses of data generated to be intelligently processed by 'smart' services. Today, accurate information about the status, location, and identity of physical entities can be made available using current technology, thus creating the opportunity for innovative applications in the IoT space [33].

Our objective is to integrate StoryBeads with the IoT to harness the above properties of the IoT. We call this envisaged system 'IoT-StoryBeads'. The StoryTeller user interface will be retained in the IoT-StoryBeads system. We will connect StoryTeller to a system that can store stories from multiple StoryTellers and also serve stories to multiple StoryTellers. This system is called 'StoryMemory'. Together, StoryTeller and StoryMemory will constitute the two subsystems of IoT-StoryBeads (Fig. 7). The StoryTeller and StoryMemory subsystems target two distinctly different user groups. StoryTeller will remain as the interface for story tellers who are ignorant of computing devices, whereas StoryMemory will serve computing devices on the Internet, including mobile phones.

VIII. Conclusion

The results of our study were a concept-evaluator and evaluation results of the use of the concept evaluator by a community member. We are planning a follow-up design iteration that will incorporate the lessons learnt. The resultant design will again be evaluated to test whether the interpretations were correctly translated. Results of the user tests will be elaborated on in future publications.

It is evident from the StoryBeads system that a simplistic handcrafted tangible user interface can interact with complex ICTs, thereby bridging the domains of non 'letterate' [34] (not able to read and write) African story telling cultures and the data processing culture of the developed world. We have demonstrated through the design descriptions of contextualised artefacts and modern computer technology that unobtrusive systems can be used to capture and store indigenous oral stories.

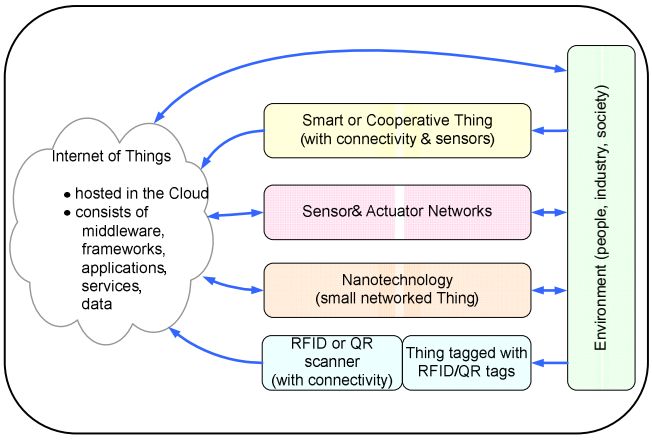

Figure 6. A conceptual model of the Internet of Things.

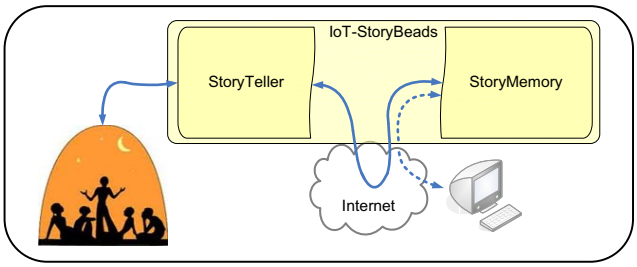

Figure 7. The future StoryBeads system will consist of two subsystems: StoryTeller, and StoryMemory.

Although the system presented is designed to better integrate modern technology with that of the rural African, it is limited to the capturing of the orator's voice. Stories are much more than the vocal utterance of the orator; it is also a performance incorporating all the physicality of the orator [4]. The system presented here can therefore be considered an improvement over previous attempts at recording stories in an African context, but not a system that captures the complete story. Such a system would be the subject of many more research projects.

In conclusion, the development of a locally contextualised system that captures oral stories for later retrieval, and that appears to the user to be as a collection of domestic objects, with the ultimate goal of preserving the stories told in a culture, looks promising.

ACKNOWLEDGMENT

Ishmael Makitla, Lesolang Stjaudis Makitla, Segolo Magana, Granny Magana, and the BaNtwane community were indispensible to the success of this project and we are truly grateful for their hospitality. We are in debt to Nicola Bidwell from the CSIR Meraka Institute who provided rich insight into the world of African cultures. This research was sponsored by the South African Department of Science and Technology, the CSIR Meraka Institute, Fonds ECTS, and the Eindhoven University of Technology.

REFERENCES

[1] R. Harms, "Oral Tradition and Ethnicity," *The Journal of Interdisciplinary History,* vol. 10, pp. pp. 61-85, 1979.

[2] N. Bidwell and D. Hardy, "Dilemmas in situating participation in rural ways of saying," in *Proceedings of the 21st Annual Conference of the Australian Computer-Human Interaction Special Interest Group: Design: Open 24/7*, New York, NY, USA, 2009, pp. 145-152.

[3] A. Jacobson-Widding, "Individual Identity in African Story Telling," *Nordic Journal of African Studies,* vol. 2, pp. 5-31, 1993.

[4] H. Scheub, "A Review of African Oral Traditions Literature," *African Studies Review,* vol. 28, pp. pp. 1-72, 1985.

[5] K. G. Tomaselli, "Stories to tell, stories to sell: resisting textualization," *Cultural Studies,* vol. 17, pp. 856-875, 2003.

[6] R. Finnegan, *The oral beyond: doing things with words in Africa*: James Currey / University of Chicago Press, 2007.

[7] N. J. Bidwell, "Anchoring Design in Rural Customs of Doing and Saying," *LNCS* vol. 5726, pp. 686-699, 2009.

[8] D. M. Frohlich*, et al.*, "StoryBank: mobile digital storytelling in a development context," in *Proceedings of the 27th international conference on Human factors in computing systems*, New York, NY, USA, 2009, pp. 1761-1770.

[9] A. Chenzira*, et al.*, "RENATI: recontextualizing narratives for tangible interfaces," in *Proceedings of the 2nd international conference on Tangible and embedded interaction*, New York, NY, USA, 2008, pp. 147-148.

[10] C. d. M. Luz*, et al.*, "Sofia: a framework for the development of group storytelling tools," in *Proceeding of the 2nd ACM international workshop on Story representation, mechanism context*, New York, NY, USA, 2008, pp. 41-48.

[11] C. Shen*, et al.*, "Sharing and building digital group histories," in *Proceedings of the 2002 ACM conference on Computer supported cooperative work*, New York, NY, USA, 2002, pp. 324-333.

[12] N. J. Bidwell*, et al.*, "Designing with Mobile Digital Storytelling in Rural Africa," in *CHI 2010*, 2010.

[13] H. Winschiers-Theophilus*, et al.*, "Determining requirements within an indigenous knowledge system of African rural communities," in *Proceedings of the 2010 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists*, New York, NY, USA, 2010, pp. 332-340.

[14] D. Hills*, et al.*, "Towards a generic framework for situated collaborative storytelling," in *Proceedings of the 5th Australasian Conference on Interactive Entertainment*, New York, NY, USA, 2008, pp. 3:1-3:6.

[15] P. Magubane, *The Bantwane: Africa's Undiscovered People*: Struik Publishers, 2001.

[16] R. Want*, et al.*, "Bridging physical and virtual worlds with electronic tags," in *CHI '99: Proceedings of the SIGCHI conference on Human factors in computing systems*, New York, NY, USA, 1999, pp. 370-377.

[17] M. Ward*, et al.*, "RFID: Frequency, standards, adoption and innovation," JISC Technology and Standards Watch2006.

[18] ISO_IEC, "18004 - Information technology — Automatic identification and data capture techniques — Bar code symbology — QR Code," ed, 2000.

[19] E. van den Hoven and B. Eggen, "Tangible Computing in Everyday Life: Extending Current Frameworks for Tangible User Interfaces with Personal Objects," *EUSAI, LNCS,* vol. 3295, pp. 230-242, 2004.

[20] E. van den Hoven and B. Eggen, "Digital Photo Browsing with Souvenirs," in *Proceeding of the Interact 2003*, 2003, pp. 1000-1003.

[21] E. van den Hoven and B. Eggen, "Informing augmented memory system design through autobiographical memory theory," *Personal and Ubiquitous Computing,* vol. 12, pp. 433-443, 2008.

[22] M. Nunes*, et al.*, "Using physical memorabilia as opportunities to move into collocated digital photo-sharing," *Int. J. Hum.-Comput. Stud.,* vol. 67, pp. 1087-1111, December 2009.

[23] A. Mazalek*, et al.*, "Tangible viewpoints: a physical approach to multimedia stories," in *MULTIMEDIA '02: Proceedings of the tenth ACM international conference on Multimedia*, New York, NY, USA, 2002, pp. 153-160.

[24] Z. Zhou*, et al.*, "3D story cube: an interactive tangible user interface for storytelling with 3D graphics and audio," *Personal Ubiquitous Comput.,* vol. 8, pp. 374-376, September 2004.

[25] A. Smith and P. Kotze, "Indigenous African artefacts: Can they serve as tangible programming objects?," in *IST-Africa 2010 Conference Proceedings*, 2010.

[26] J. Z. Mashiyane, "Beadwork - Its cultural and linguistic significance among the South African Ndebele people," University of Zululand, 2006.

[27] W. Bozongwana, "Common beliefs and signs of coming events," ed: http://www.inkundla.net/net/imbali/commonbeliefsandsigns.php, 1983.

[28] M. Heijboer and E. van den Hoven, "Keeping up appearances: interpretation of tangible artifact design," in *Proceedings of the 5th Nordic Conference on Human-Computer interaction: Building Bridges*, 2008, pp. 162-171.

[29] D. A. Norman, *The design of everyday things*: Doubleday, 1990.

[30] J. B. Waltherl*, et al.*, "The Role of Friends' Appearance and Behavior on Evaluations of Individuals on Facebook: Are We Known by the Company We Keep?," *Human Communication Research,* vol. 34, pp. 28-49, 2008.

[31] G. Schulmeister, "The Third Wave of Computing," Reykjavik University, 2008, unpublished.

[32] M. Chui*, et al.*, "The Internet of Things," *McKinsey Quarterly,* 2010.

[33] Sundmaeker*, et al.*, "Vision and Challenges for Realising the Internet of Things," European Commission - Information Society and Media 2010.

[34] S. Papert, *The children's machine: rethinking school in the age of the computer*. New York, NY, USA: Basic Books, Inc., 1993.