

StoryBeads: Preserving Indigenous Knowledge through Tangible Interaction Design

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Abstract— This paper addresses the need to preserve culturally unique knowledge for future generations. This user-centered design-research case study focused on preserving Indigenous Knowledge (IK) of the South-African BaNtwane culture, specifically focusing on their rich beadwork and oral traditions. Our approach allows for design research in a scenario where the community is represented by a few prominent members, simultaneously making provision for the incorporation of modern technology in a society trailing in technology adoption. The study resulted in a recording device that fits the target group’s oral tradition and is based on a concept in which oral stories are recorded and associated with tangible beads that can be incorporated into traditional beadwork. The device and interaction design embraces the culture’s aesthetics and existing IK mechanisms.

Keywords- *IK, Indigenous Knowledge, Orality, Tangible Interaction, Designing for Cultures, Design Research, BaNtwane, Digital Storytelling.*

I. INTRODUCTION

The HCI field focusing on indigenous knowledge preservation is becoming increasingly important since the need for preservation systems is getting poignantly visible through the disappearing of indigenous knowledge in many communities.

We view the process of preserving (as opposed to conserving) indigenous knowledge as being dynamic. In this process, the values of the cultural traditions are captured in a way that fits the contemporary lifestyle of the community itself. Cultures are dynamic [1] and a preservation system should embrace this quality to make it relevant to future generations. There is significant interest within the IKS research community to develop recording mechanisms that can capture indigenous knowledge. Existing projects mainly focus on the technology needed for such recording systems, neglecting the cultural dimension (for example Greyling and McNulty [2] and Literacybridge [3]). In contrast, our approach is tailored to fit the target culture. Our research focused on the South African BaNtwane tribe. This tribe was

selected because 1- we had access to a community member who acted as translator and assisted in establishing contact with the community, and 2- the BaNtwane have a rich beadwork tradition (Figure 1 shows examples) and an oral foundation.

BaNtwane beadwork carries symbolic meaning; a necklace ‘says’ something about the wearer’s status, the wearer’s tribal affiliation, and significant events the wearer has experienced. The BaNtwane’s process for transferring knowledge evolved over many generations into the current combination of being 1- learning-through-seeing, 2- making connections between beadwork, a particular event, and the person wearing it, 3- mother/daughter topical conversations, and 4- storytelling. Traditional modes of knowledge transfer require direct contact between the person transmitting and the person receiving it. Westernization and migration of community members have made this mode of transfer less relevant due to the reduced person-to-person contact. Consequently, not all tribe members currently understand the embedded meaning of the beadwork and the tribe now fears that their cultural heritage might disappear. The StoryBeads case study provides a means to transfer indigenous knowledge between generations and to recall the knowledge indefinitely in a way, which suits the characteristics of the BaNtwane, in particular, their way of storytelling and their aesthetics.

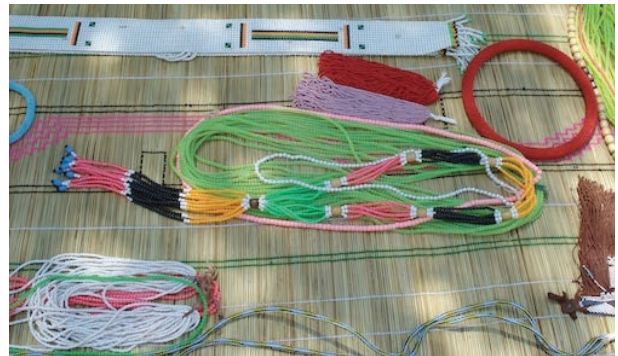


Figure 1. The traditional BaNtwane beadwork.

¹ Research was performed at Eindhoven University of Technology

The paper is structured as follows: Section 2 provides a literature overview. Section 3 describes the methodology whilst Section 4 introduces the design process. Section 5 describes the improved design and Section 6 covers the introduction of this design to the end users. Section 7 suggests design improvement and includes a discussion. Section 8 concludes.

II. LITERATURE OVERVIEW

Indigenous Knowledge has the following characteristics, it is: 1- specific to a culture or community [4]; 2- dynamic and flexible in nature, consisting only of currently relevant knowledge [5]; 3- shared between successive generations [4] in a socially segmented manner (no single person has the complete body of Indigenous Knowledge); and 4- orally transmitted [4] (transfer is done verbally and not by means of the written word [6]). Connected to the latter is the concept of “Orality”.

Orality is oral transfer with a strong literacy focus [7] and relies on repetition for its success [6, 8]. Other important dimensions of orality include performance, verbal variability, the influence of the audience and context, and the linkage of tales that leads to complex stories [6, 9]. Performance in particular adds significant richness to the story through vocal emotions, vocal beauty, facial expression, vocal expressiveness, and bodily movement. Performance invites the storyteller to develop these additional resources and find a personal narration style to make the performance memorable. However, researchers often neglect the performance dimension due to the practical challenges faced when capturing orality, and the unconscious reference scientific recorders and readers make to more familiar dimensions of literature, in particular the written dimension, in which performance is not considered relevant [6].

When designing user interfaces for an oral culture, orality has to be considered [10], the design should be focused on providing narrative elements, and abstractions should be avoided in the design. The inclusion of rhyme and dramatization in the design is appropriate as they facilitate information recollection [10].

A search for interaction design knowledge in support of IK preservation yielded related examples from the field of tangible interaction. These examples support the user in interacting with digital data by means of an interface in the physical world [11]. The proposed use of traditional African artifacts as tangible programming elements [12] explores cultural artifacts as Tangible User Interfaces (TUI's). Personal tangible objects [13, 14] are objects with which the user has an existing association. Natural mappings may therefore already exist between specific digital information and specific personal tangible objects. This concept may be extended to cultural tangible objects. Cultural artifacts play an important role in IK systems, serving as symbolic frameworks that guide appropriate behavior amongst community members in various situations [15]. Taking those objects as a foundation for TUI's may help the user understand digital information that has now been associated with them. A tangible interaction design approach was an obvious choice to meet the product requirements (it had to

be: mobile, low cost, reliable and small enough to fit inside beads) as well as fitting for the user profile (late adopters of technology).

Orally oriented persons prefer the use of speech, gesture, and bodily interaction above the use of a visual context [16]. It is for this reason that our literature study focused on digital storytelling projects that emphasize the use of audio. Many IK-related projects (for example Bidwell et al [17] and Frohlich et al [18]) rely on technology such as mobile phones, which can both record and play stories back. Talking Books [3] is similar to our project as it only relies on audio and it can both record and play stories back. However, Talking Books differs in that it makes use of ‘Western’ buttons to operate the device.

Our project incorporates TUI's in the form of digital beads. Similar to White and Steel's work [19], these beads are modular and can be connected, thereby allowing stories to physically ‘grow’.

Digital jewelry should focus on aesthetics in a similar way as 'normal' jewelry does [20]. Barry and Davenport [21] discuss the use of beads as elements that support storytelling. Their work differs from our own project in the following ways: 1- our project utilizes audio whilst Barry and Davenport use video messages; 2- to our target group it is important that the technology is not overly intrusive whilst Barry and Davenport expose the underlying technology to the user.

Spyn [22], combines craftsmanship and storytelling by making the object, created throughout the storytelling, the carrier of the story. In our project, the story is only created after the beadwork has been made. Similar to our project, White [23] exploits crafted tangible objects as the interface with which a user can browse stories. These objects were designed to have a ‘low-tech’ appearance, thus making them better understood by their target group (the elderly).

To conclude, when a recording mechanism is designed to preserve IK, such a mechanism should suit the various dimensions of orality.

III. METHODOLOGY

Our design had to consider both the storytelling tradition and the cultural aesthetics of the target group. The result was a design customized for a specific group.

We followed an iterative design research process [24], and specifically a user-centered approach (as in van den Hoven et al [25]). This methodology is well suited when some information is lacking at the onset of a project. Through design iterations and interactions with the target group, additional information was obtained to inform the following iteration, in which the artifact may be discarded in favor of an improved one. By taking a design research approach, the outcome and the process of this case study differs considerably from already existing work focusing on the preservation of indigenous knowledge.

A design approach links creativity and innovation [26], which enables taking new perspectives and coming up with attractive and practical solutions that would otherwise be difficult to envision.

In the study presented in this paper we aimed to design for real people, by focusing on real needs and is therefore human-centered [26]. StoryBeads is specifically designed for the BaNtwane community.

Another aspect of the design process, important to make this case study different from existing work, was 'thinking through making'. By using design as a tool that could be placed in the life of the BaNtwane, we could explore our understanding and make it, with every iteration, converge more towards the reality of the users [27]. Especially in cases where the cultural background of the researchers is different from the target group, we see this as valuable.

The combination of those three characteristics of the design approach made this research stand out from other research that focuses on preserving indigenous knowledge. Most of the other research done in this area has a technological foundation. Already existing Western technologies (such as video recorders or mobile phones) are often used in order to provide a solution. However, those solutions are incapable of connecting with the reality of the user leading to solutions that do not necessarily fit anyone or any context in particular [28].

In the process of identifying our knowledge sources we took into account that Indigenous Knowledge is socially segmented. We identified two groupings of community members who were most knowledgeable about the beadwork: 1- beadwork ladies who specialize, often as their profession, in the making of beadwork, and 2- traditional healers who know their own culture's beadwork well in addition to the beadwork of other cultures. These two groups were consulted extensively in the design of StoryBeads.

IV. DESIGN PROCESS OF STORYBEADS

A culture could inadvertently be influenced by the introduction of a new design. We minimized this by conducting interviews and developing a design that accommodated the community's storytelling habits, traditions, and cultural values. The interviews were dependent on a translator because most BaNtwane community members either did not speak English or felt uncomfortable in conversing in English with outsiders.

A. Understanding Context: Interview with Beadwork Lady

A beadwork lady (Lady A, Figure 2a) informed us on the tribe's beadwork tradition. We combined two methods to acquire the information; being a semi-structured interview and an introduction to the cultural artifacts.

The semi-structured interview allowed for flexibility and helped to confirm our understanding. Questions were asked regarding 1- when the beadwork was worn, 2- how the meaning of the beadwork was transmitted, and 3- what the meanings of the various beadwork pieces were. Lady A thereby also clarified the cultural traditions.

The combined method provided information about 1- how the artifacts were worn, 2- the various traditional colors incorporated in BaNtwane beadwork, and 3- how the beadwork was crafted. From this interaction we concluded that: 1- colors and patterns can 'tell' a story, 2- beadwork is made using different shapes, patterns and color combinations

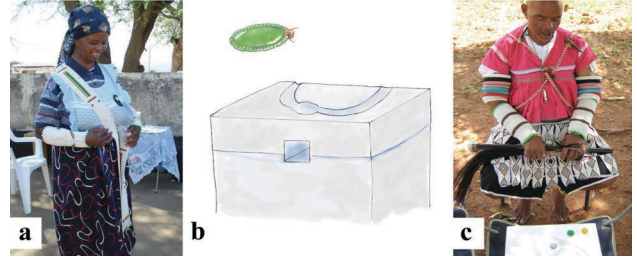


Figure 2. (a) interview with Lady A, (b) concept drawing of concept demonstrator, and (c) interview with the traditional healer.

and rules prescribe what to wear and when to wear it, 3- the beadwork is no longer part of daily attire (thereby disrupting the traditional mode of Indigenous Knowledge transfer), 4- beadwork is mostly intended for women (making it and wearing it), and 5- the traditional modes of transfer are as described in the introduction of this paper. Since we followed an iterative design process and wanted to evaluate our ideas in several stages of the process (similar to van den Hoven et al's work [25]) we introduced two types of Tangible User Interfaces (TUI's).

The first TUI type can be described as 'Western-oriented symbolic', with the beads shaped like 'play', 'record', 'forward', and 'rewind' buttons as is commonly found on electronic audio/video devices. The rationale behind introducing this TUI type was that it caters for story editing. Lady A did not understand this symbolic interface.

The second TUI type consisted of a central bead (containing the main story) to which other beads (containing story extensions) could be attached. The rationale was that this allows stories to 'grow' both physically and literally (confirming Finnegan's [6] and White & Steel's [19] findings). Lady A commented that it gave her the ability to record a story, which her children could extend later. According to her, this fitted the current tradition of passing on heirlooms to the next generation.

Thus, we concluded that: 1- Western symbolism should be avoided; 2- the recording mechanism should contain a functionality to extend an existing story.

B. Design Implementation: Materializing the Concept

These findings, combined with the literature research, were realized as a (fully working) conceptual recording/play back device (Figure 2b & 2c). It consisted of two elements: 1- a recording/ play back device ('StoryTeller') and 2- physical handcrafted beads ('eBeads'). eBeads function as TUI's that activate the StoryTeller to either 1- record and associate a story with the eBead, 2- play back a story that has previously been associated with that particular eBead, or 3- delete an associated story when the eBead is dropped through a hole in the surface of the StoryTeller. Once the eBead has passed through the hole the eBead would be 'empty' again. Individual eBeads served as narrative elements and multiple eBeads could be strung together to form a larger piece containing story extensions.

The electronic circuitry (see Figure 3) consisted of a radio frequency identification (RFID) reader, an audio

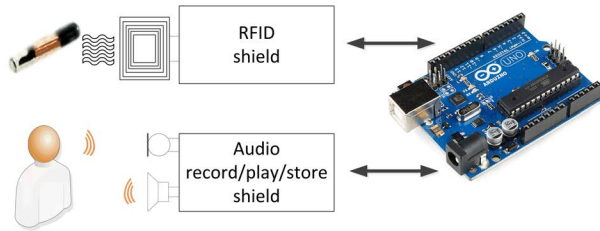


Figure 3. Architecture of the electronic circuitry.

recorder/playback/storage circuit, and an Arduino [29] controller. Custom-written software monitored data received from the RFID reader, comparing the detected eBead with a list of previously recorded stories. If a match was found, the stored recording was played back over the built-in loudspeaker. If a match was not found, a prompting message was played over the loudspeaker and sounds picked up by the built-in microphone saved to non-volatile memory. The audio recording was terminated when the RFID reader no longer detected the presence of the eBead. More details about the technology and system implementation can be found in [30].

The eBeads were in the colors green, blue, and yellow and could optionally be combined with other beads to form a larger beadwork piece.

StoryBeads incorporated an oral interface, complementing the tangible interface and guiding the user through the interaction options. Two versions of the oral interface were implemented: 1- a concise version (e.g. “Please record your story.”), and 2- a verbose version (e.g.: “There is a bead without a story lying on the surface. Maybe you would like to add a story to it, so that the story can be passed on with the beadwork you connect it to. You can start telling your story after I have finished this explanation. Feel free to share your story. You can now start telling...”)). Both versions were recorded in the mother tongue of the BaNtwane tribe, which is a Pedi dialect.

C. Informal Evaluation: Interview with Traditional Healer

We visited the local traditional healer (Figure 2c) to evaluate the fit of the concept demonstrator. Our initial discussions focused on the beadwork and the need for preservation. The concise and verbose modes and the deletion function were then explained.

The concise mode was used first and the following was observed: 1- the healer found it difficult to follow the instructions in the concise mode (confirming Rosenfield et al’s [10] findings) and requested our assistance. In contrast, the verbose mode was easily followed and he commented as such: “this is clear to me, the other instruction makes me feel uncomfortable”. 2- other tribes had already been associated with the eBead colors, making these colors inappropriate. However, the healer commented that the green bead was still of value as it represented South Africa. The healer chose to record his story using the green bead. 3- the healer identified the possibility of extending an existing story using additional eBeads, thereby discovering the notion of physically connecting stories. 4- the ‘delete’ function elicited a strong



Figure 4. (a) the final StoryTeller (a fully working concept demonstrator), and (b) the final eBeads.

reaction and the healer remarking as follows: “We would never throw a story away; we are not a throw-away society; the story is valuable as it is.”

We could therefore add three additional conclusions to the two derived from the interview with Lady A: 3- an existing story should not be altered, 4- the chosen colors should not have other meanings associated to them, and 5- the oral interface should contain verbose explanations.

V. FINAL DESIGN OF STORYBEADS

Six factors distilled from the previous design iteration were incorporated in the final design (see Figure 4), these are: 1- the StoryBeads aesthetics, choice of materials, and the choice of technology address the interests of community members, 2- the aesthetics inspire the community and had no prior meaning attached to it. This was achieved by incorporating materials and techniques in common use by the community and selecting colors that match, yet distinct from traditional beadwork. 3- StoryBeads meets the requirements of being low cost, reliable, small in size, and mobile. 4- a circular ‘gutter’ accommodates any size beadwork. 5- stories can be shared anywhere because the design is portable and large enough for the audience to sit around. 6- eBeads can be threaded together to extend a story.

The final design was made into a fully working concept demonstrator. The electronic circuitry was placed inside the basket. An explanation on the use can be found in a scenario movie [31].

VI. STORYTELLING SESSIONS WITH STORYBEADS

A translator accompanied us at two community visits as we introduced the final design to two beadwork ladies.

First Visit - Initial Introductions: The goals of the first visit were to, 1- identify and acquaint ourselves with interested beadwork ladies, and 2- to introduce the project to our translator. We asked the leading community beadwork lady (Lady B, Figure 5a) to prepare one or more stories that, according to her, were important for beadwork preservation. She agreed since she was interested in the idea of telling her stories to the younger generation; she considered the preservation of beadwork knowledge to be important.

Second Visit - First Storytelling Session: Upon our arrival at the community the translator immediately took



Figure 5. Storytelling session with Lady B (a) and Lady C (b)

possession of the StoryTeller and the eBeads we had brought with us. We did not question this action but decided to observe what would unfold. For each session during this visit, the translator would hand the StoryTeller and eBeads to the particular beadwork lady who in turn placed them on the ground to her liking.

We were introduced to a third beadwork lady (Lady C, Figure 5b) who seemed reluctant to participate since she had not been informed about our visit and felt unprepared. However, she agreed to participate but experienced difficulties.

Second Visit - Second Storytelling Session: Family members and friends (five adults and six youths) had already gathered around Lady B as she worked on her beadwork. She placed the StoryTeller and eBeads in the middle of the audience and requested the translator to operate the StoryTeller. She followed its verbal instructions and told her story without incident.

VII. RESULTS AND DISCUSSION

What follows are the results and discussion about: 1- the storytelling sessions, 2- our interactions with the BaNtwane, and 3- the influence of StoryBeads.

A. Storytelling Sessions

We had requested Lady B and Lady C to use StoryBeads and capture stories. Although Lady C seemed to be unprepared for the task, the opposite was true for Lady B. The stories concerned a variety of beadwork pieces (a beadwork piece is a collection of multiple beads such as a necklace).

Lady C: Lady C shared three stories that can be described as ‘a dialogue with the translator’; Lady C’s statements were single sentences. Following each sentence, the translator would ask her to elaborate and that resulted in a longer response. Lady C requested that the translator would operate the StoryBeads, freeing her to tell the story. The stories dealt with the pieces as distinct and separate items. The three chosen pieces were the ones she had been working on upon our arrival, and she used them as the subjects of her three, unrelated, stories. She elaborated on how the pieces were donned and for which occasion. Each story lasted approximately one minute.

Lady B: This session differed substantially from the one with Lady C. What follows is an account of Lady B’s storytelling: She sat upright on the floor and requested the

translator to place the eBead on the StoryTeller. Having listened to the prompt, she told her story. Her voice was loud and clear, maintaining a relaxed pace. The beadwork pieces lay in front of her and when she talked about one she would show it to the audience. She did not look at the StoryTeller but instead looked at the audience seated around her. She completed her story in 15 minutes. She then asked the translator to end the recording. When the translator placed the eBead back onto the StoryTeller, Lady B repeated every word in sync with the recording. When asked about this she said: “You asked me to prepare this and that is what I did. I created a story. And a story should be properly rehearsed; who wants to listen to the story if it is not done well...?”

In contrast to Lady C’s approach, Lady B talked about various beadwork pieces simultaneously and used the event at which they were worn (an initiation rite) as a common factor to bind the story. She had selected the pieces as she prepared for the session prior to our arrival, and only one story was prepared. Although her story included various beadwork pieces, she kept referring to the first piece. She concluded by saying that the eBead should be connected to the first piece. As the session concluded she commented that the most recently used eBead should not get ‘lost’ amongst the other beads, and that we should take this eBead so that other people could also listen to the story.

We deduce that Lady B did not merely consider the eBeads as actuators to operate the StoryTeller, but also as physical story representations. In that sense, the eBeads seem to work well as Tangible User Interfaces. Our informal discussions with Bidwell indicated that this session seemed to reflect traditional storytelling behavior well. We also deduce that the StoryBeads design had facilitated two important storytelling dimensions (performance and audience), as follows: 1- aspects of performance emerged during the second session. For example, when we queried Lady B on her synchronized repetition she explained that a story is only worth telling when it has been well prepared and rehearsed. We had witnessed how Lady B enhanced her performance through vocal expressiveness, beauty of the voice, emotions in the voice, and bodily movements. Thus, by preparing properly, a storyteller can enhance performance by using additional resources. 2- the aspect of audience emerged in the second session when Lady B positioned herself in front of the StoryTeller (amongst her audience in the middle of the ring of people). Once the instructions had been heard and the storytelling commenced, Lady B shifted her attention from the StoryTeller to the audience and directed her story at them.

We hypothesize that this storytelling behavior arose due to the design aesthetics. The StoryTeller was accepted as having originated in the community itself. We were often asked who had designed and created StoryBeads (for example “Who made this for you? Since only people in traditional African villages would know how to make something like that”). Our aim was for the community to accept the design as one of their own, even though it was novel. This approach also respects their tradition. We believe that the way we applied technology resulted in a good fit within this community. Since the technology played a

secondary role we believe that it did not detract from the storytelling. This was probably due to Tangible Interaction having been chosen as the interaction modality as it resulted in a low-tech feel. Something that requires further investigation is the extent to which StoryBeads supports the community's way of organizing knowledge, and how the eBeads will be used for this purpose. It might be that StoryBeads is too static for the dynamic nature of orality. It would be interesting to investigate why the translator was so eager to take ownership of the StoryBeads.

Translators: The case study transpired with the help of two translators. Both were well-respected community members. However, they had a different approach towards translating: The first translator's translations were very precise and detailed. He facilitated, during the interview with Lady A and the traditional healer, dialogues between the community members and the researchers. The translations of the second translator were summaries of the things that were said, rather than detailed and precise translations. This made the researchers, during the final storytelling sessions, become outsiders that witnessed the sessions without being involved. This different level of involvement in the final storytelling session might have resulted in a more natural behavior reflecting how StoryBeads would be used in the community. However, without the approach of the first translator it would have been impossible to get a deep understanding of the BaNtwane culture.

B. Interacting with the BaNtwane

Our process and methods helped us to 'step out' of our own Western culture and into that of the BaNtwane. We correctly assumed that the cultural differences were too big to finalize a design without interacting with the BaNtwane at different stages of the design process. Yet, we made culturally biased assumptions, such as the option to delete a recorded story.

It was difficult to source participants that the community members deemed appropriate. As a result very few people participated in this study. This is an important dimension to consider as Indigenous Knowledge is socially segmented and only a few persons are experts on the beadwork and its related traditions. StoryBeads relies on these same persons for its stories. Future research could benefit from the involvement of younger community members by understanding their impression of the current design.

Our first interactions with Lady C were at the onset of the storytelling session. It was evident from her reaction that she did not fully understand who we were, or what our project entailed. Lady C was probably uncomfortable because we, being strangers to her, were introducing something that she did not have any comprehension of. In hindsight we realized that we should have handled the situation with more sensitivity by allowing her time to consider the project and her role in it. We should probably not have placed her in the uncomfortable position in which she had to come up with a story without having had sufficient time for preparation, which seems to be important to the BaNtwane.

C. Influencing the BaNtwane

StoryBeads introduces digital storytelling as a new mode of knowledge transfer. If StoryBeads is widely deployed it might disrupt the current balance of how bead knowledge is transferred within the BaNtwane community. Cultures are dynamic by nature [1] and perhaps for a culture to survive, existing knowledge-transfer processes need to be adapted. It remains to be seen what the long-term effect of such a disruption will be. It would be useful to evaluate StoryBeads over a longer period in order to gain a thorough understanding on 1- how this product is used in the community, 2- what kind of stories are truly recorded, 3- how often stories are recorded, and 4- to discover what happens with the eBeads.

The BaNtwane community commented as follows, seemingly indicating their acceptance of StoryBeads: 1- "[StoryBeads is like] having all the wise men in a basket" According to some community members, children could learn about their culture if they have access to StoryBeads, and 2- StoryBeads is seen by different BaNtwane community members as a mechanism for listening to the voices of their ancestors.

VIII. CONCLUSIONS

The goal of this design research project was to create a recording mechanism that 1- served as an aid to preserve knowledge, which is linked to traditional beadwork, and 2- fitted the cultural traditions of the community. We followed a culture-focused approach in contrast to the more common technology perspective approach. The iterative design process included multiple sessions with community members. This resulted in the StoryBeads design, which is a recording and playback device incorporating technology-enhanced beads (eBeads). StoryBeads was evaluated during two storytelling sessions, in which we identified both performance and audience characteristics. We anticipate that these characteristics will encourage future orality.

These findings seem to indicate that StoryBeads fits the cultural traditions of the BaNtwane community well. Although the case study itself is not generalizable (it was customized for a community), three important aspects can be taken from this study. 1- The approach: when designing for an indigenous community, understand who the expert-users are. This is important since the division of knowledge is socially segmented and only certain members of the community are considered appropriate experts to inform design decisions. Who the expert-users are, depends on the culture. 2- The iterative process followed in gaining an understanding of the culture is of major importance in deriving a culturally relevant design: it enabled us to get an understanding of the differences between the researchers' culture and the target culture. 3- StoryBeads shows the success that implementing tangible interaction could have in similar communities and projects. It enabled the users, who were not familiar with modern technology, to connect digital information to objects, which they could relate to. Those objects fit the artifacts already used in their culture.

ACKNOWLEDGEMENTS

We thank the BaNtwane community members, who introduced us to the rich cultural traditions of the BaNtwane culture, and to the importance of preserving cultural stories. Dr. Bidwell provided insight into the world of African cultures. This research was sponsored by the South African Department of Science and Technology, the CSIR, Fonds ECTS, and the Eindhoven University of Technology.

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