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ORIGINAL ARTICLE

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The Periscope: supporting a computer enhanced field trip for children

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Abstract This paper describes an interactive device, the Periscope, designed to be used as an educational tool featured during a children's digitally enhanced field trip in a woodland setting. The Periscope assembly, including a display and RFID equipped tangibles, is controlled using handles that enable it to be raised and rotated. The display is controlled by rotating the Periscope, or alternatively by twisting the handles. A set of tangibles, a collection of Petri dishes fitted with RFID tags, enable the children to carry out experiments with the results being shown on the display. Field trials are also outlined in which the effectiveness of this design is established. In conclusion, we discuss the aesthetic design issues raised by introducing digital technology into everyday environments.

Keywords Educational tool · Interactive display · RFID · Tags · Tangibles

1 Introduction

A playful learning experience, called the Ambient Wood, was created where children explored and reflected upon a woodland environment that had been augmented with a range of digital abstractions. The latter were represented in a number of *ambient* ways, designed to provoke children to stop, wonder and learn when moving through and interacting with aspects of the physical environment. A variety of devices and multi-modal displays were used to trigger and present the 'added' digital information. As part of this project, the challenge of providing an interactive computer display integrated into the woodland setting was addressed by the creation of an unusual appliance – the Periscope.

The Periscope is a networked device designed to allow children access to information that would not necessarily be available to them within the context of a conventional field trip. Combining information and navigation, the Periscope contains a Director movie showing a panorama of the woodland and a number of thumbnail images representing links to QuickTime movies. By navigating through the panorama, finding and choosing the links, users are able to view in detail the lifecycles of woodlice; tiny creatures that feed from the leaves and leaf-litter; and the way the wood changes its character over a season, or over a period of fifty years. They can also see time-delay footage of various stages of the lifecycle of bluebells, and some of the interdependencies that are an inherent part of the woodland's character. Additional information, in the form of Flash animations, can be accessed by adding or removing Radio Frequency Identification (RFID) tagged objects within range of an RFID tag reader aerial which is among the objects protruding from the Periscope's stem.

The underlying concept guiding the design aesthetic of the periscope was the intention to create a hi-tech organic hybrid. The 12 year olds with whom we did initial testing seemed most impressed, interested in and intrigued by visible technology that seemed more advanced than that with which they were familiar. Our previous research into children's understanding of mixed reality environments also indicated much fascination and curiosity about how the technology worked [1,2]. Hence, though initially conceived as a discreet 'portal' into the wood's hidden life, the Periscope became less and less hidden or pervasive and more of a visually and physically present piece of unfamiliar technology in the woodland habitat. Rather than create a device and hide it or disguise it as part of the environment we

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Fig. 1 Approaching the Periscope

deliberately chose to create a technological artifact that was incongruous and highly visible. The desire was to create a unique device that intrigued the children while challenging their assumptions about technology.

2 Design and construction

2.1 Physicality, navigation and interaction

The Periscope consists of a 6.5″ (diagonal) flat screen display mounted onto an adjustable tubular stainless steel stem (see Fig. 2). The TFT LCD screen is protected from light by a custom-made black rubber hood. Curved aluminium wires (reminiscent of insect antennae) maintain the hood's distinctly organic, almost flower-like form. Extruding from either side of the rear of the hooded screen are two handles used for navigating through the onscreen panorama. To navigate horizontally, the user rotates the entire hooded screen on its axis. To navigate vertically the user turns the handles in place, forwards or backwards (up or down).

Two potentiometers are embedded into the Periscope – one into one of the protruding handles, the other into the top of the stem of the periscope connecting directly to the TV screen mounting. The two handles are physically joined preventing them from being turned independently. The potentiometers are connected by USB to the computer that runs the Periscope's Director movie. This USB cable and the cables from the flat TV screen pass through the centre of the Periscope's stem and exit through the bottom of its external, adjustable, upper portion (as shown Fig. 3).

The Periscope's stem was designed to be of adjustable height as the variance in height of 10–12 year-olds can be quite dramatic. The comfortable viewing height of the Periscope's screen is anywhere from three foot six inches through to five foot. The height is maintained with a simple grub screw. We found that it was best to choose an appropriate height for each group of users and lock it off to avoid the assumption that this was a navigational function. In the case of a higher comfortable viewing height being necessary, the Periscope itself could be installed on an appropriately raised platform or box (in which could be placed the necessary hardware). In the Ambient Wood trials the Periscope was pegged into the ground using tent pegs and the base camouflaged with leaf-litter. The associated hardware was hidden at a close distance except for audio loudspeakers that were left visible at the base of the Periscope's stem.

2.2 'Entwined' Petri dishes

A number of curved items protrude from the stem of the periscope about two thirds of the way up from the ground. One of these is a circular copper aerial that is attached to an RFID tag reader shown in Fig. 4(b) with two tagged items, a fungi-filled Petri dish and an oversized spider in its web, placed within its range. The resistors and capacitors which form part of the associated circuitry, and which protrude from the exterior of the aerial, are enclosed in a small transparent Petri dish (see also Fig. 4(b)). This provides electrical and thermal

Fig. 2 The Periscope display

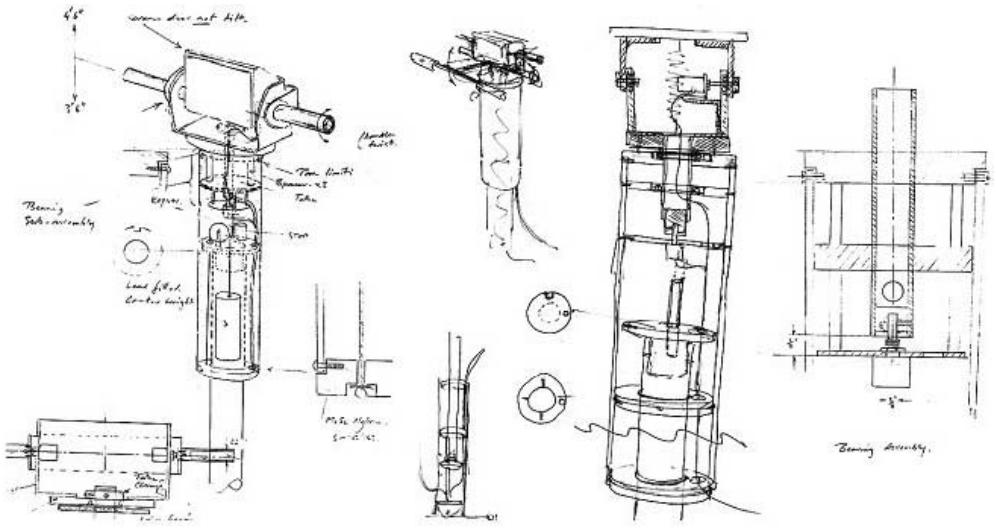

Fig. 3 Design sketches

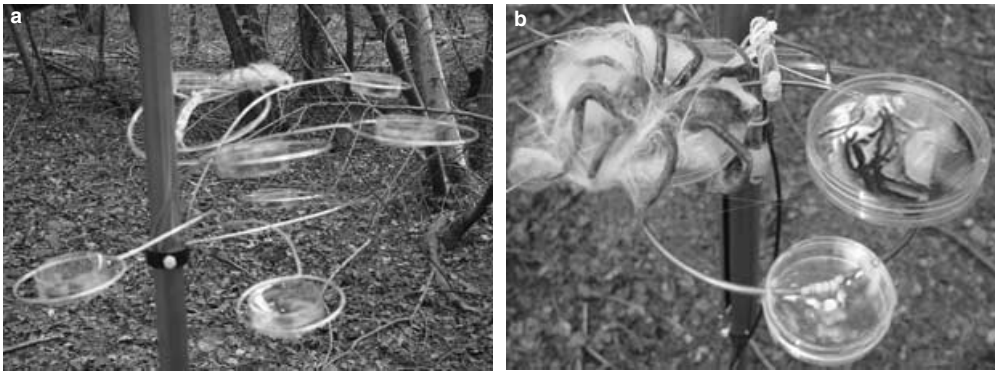

Fig. 4a,b The 'Entwined' Petri Dish Assembly

insulation while at the same time maintaining a transparency of technology. The aerial is attached to the Periscope's stem with curved, tubular (non-conductive), rigid plastic. The aerial itself is crisscrossed with a network of 'invisible' nylon thread and has a Petri-dish holder hovering just above it, within its reading range, suspended in place with the use of another curved piece of non-conductive plastic tubing. The Petri dish holder and the network of nylon thread guide the user to appropriate placement of tagged objects. It is not necessary that the objects be placed into the Petri dish holder, though they must be placed within approximately 5cm – the limited range of the RFID tag reader aerial. The cable which connects the aerial to the RFID tag reader winds vine-like around and down the Periscope's stem, maintaining the organic metaphor which drives the design aesthetic of the Periscope.

Echoing the form of the aerial and its Petri dish holder are a number of aluminium wands which curve off from the periscope's stem in various directions, and which end in circles, approximately the same size as the tag-reader aerial. 'Entwined' in each of these circles with a network of 'invisible' nylon thread (identical in form to the network of thread on the tag reader aerial) are various other Petri dishes which contain samples of flora and fauna taken from the woodland habitat (see Fig. 5). Each of these elements – bluebells, acorns, leaf-litter, critters, fungi, etc. – relates directly to the QuickTime movies which can be viewed on the periscope screen by navigating through the panorama of the wood. Clearly visible on the base of each of the Petri dishes are RFID tags. Thus these items act as both a guide to what can be viewed in the Periscope, and as a guide for the children to use for further experimentation when they return to the Periscope with other tagged items – a fungi-filled Petri dish and a large artificial spider.

At the Periscope the children place the RFID-tagged tangibles – the Petri dish of fungi and the spider – within range of the RFID tag reader aerial. Once a tagged item is placed within range, a Flash animation begins to play on the periscope's screen. The animation shows the likely outcome of introducing either one or the other or both of the tagged items into the woodland environment. These were:

Spider alone. The spider consumes the critters that inhabit the normally nutrient-rich leaf-litter, which then becomes impoverished. Many of the seasonal plants and flowers, such as the bluebells, for example, rely on the

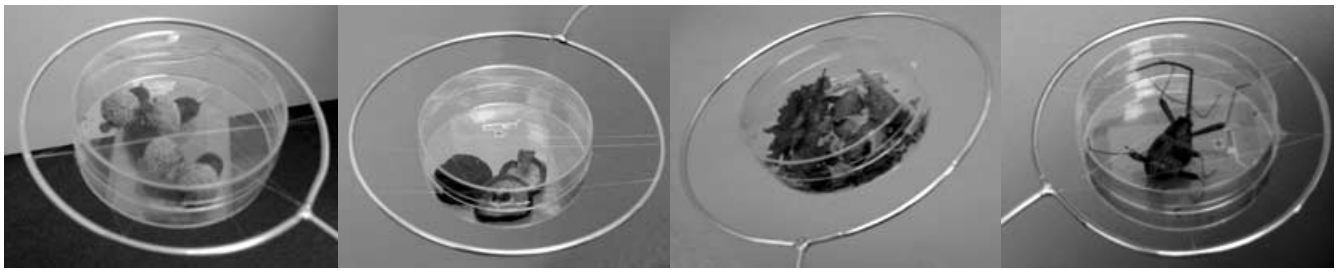

Fig. 5 RFID equipped Petri dishes

leaf-litter for their sustenance and so, over time, it becomes increasingly difficult for them to continue to grow. In reality, though, the spider population is controlled by birdlife.

Bootlace fungus alone. The bootlace fungus (Armillaria) attaches itself to birch trees, but not to oaks. It is in the character of southeastern English woodlands to change over time (approximately fifty years) from mixed birch/oak habitats to oak only environments. Introducing the fungus significantly speeds up this process.

White spider and bootlace fungus combined. The introduction of the two organisms together has the most detrimental effect on the habitat, causing two organisms to die and the balance of the habitat to change dramatically.

2.3 Network services

A wireless Local Area Network (LAN) was created in the woodland as part of the Ambient Wood project. The Periscope was connected to this LAN and sent out notifications of events to a network server as they happened. The system architecture employed Elvin (a content-based notification and messaging service [3]) connected to a MUD environment [4,5]. This allowed progress and usage to be monitored and affected if necessary to ensure that the children were not seduced into the virtual world of the periscope to the detriment of the 'real-world' experience of a field trip. The Periscope was designed and created to enhance this real-world experience, not to replace it.

Each time a QuickTime movie was viewed in the Periscope a 'whichMoviePlayed' notification was sent. This allowed the MUD to trigger appropriate audio (and accompanying visual) information nearby if several QuickTimes were viewed in quick succession. The intention was to momentarily entice the children away from the Periscope and so diversify their sources of information. Numerous correspondences were made between the QuickTime movies within the periscope and the list of sounds available in order to avoid repetition in the case that certain sounds had already been triggered through alternate means. Having ELVIN 'listen' and notify Director of the presence of tagged items also freed up the Director movie from continually checking for this event, thus substantially saving processing power.

The decision to incorporate the periscope into the network and to give appropriate (though not obligatory) sound links which could be triggered elsewhere in the woodland environment was specifically to avoid ongoing immersion in the digital representation which could arise out of being seduced by the interactive and visual possibilities made available by the device. Overall, this architecture allowed a dynamic flexibility for the retrieval and triggering of information by the user so that the maximum amount of information could be accessed during any single field trip. At the same time the children could enjoy the presence and possibilities afforded by technology without the technology taking primacy over the actual experience of being out in the woods, immersed in the richness offered by such a natural environment.

Fig. 6a,b Placing a tagged object on the reader

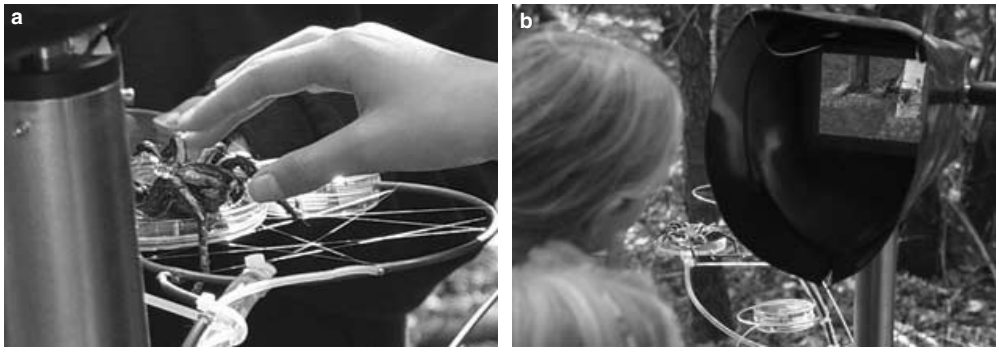

Fig. 7a,b The Director Movie

3 Using the Periscope

3.1 The director movie – what the children saw on the screen

When the children approach the hooded screen of the periscope a panorama of the woodland habitat is displayed. The panorama viewed onscreen is exactly what the viewer would see if the screen itself was a window into the surrounding woodland with the exception of the thumbnails linking to the Quicktime movies, and the aiming sight, or crosshairs, which allow pointed navigation through the panorama. The movies contained within the Periscope relate directly to the elements trapped in the protruding Petri dishes and give access to information that would not normally be available during a field trip to the woods. When the child rotates the hooded screen on its axis or turns the handles up or down, the entire panorama and associated thumbnails moved accordingly. When the thumbnails pass underneath the centre of the crosshairs, they expand in order to make their contents clearly visible. If the child continues to navigate through the panorama, the thumbnail shrinks back to its original size. In the event that the child pauses over the enlarged thumbnail, the Director movie links to the corresponding QuickTime movie. Once the QuickTime movie has been viewed, the screen reverts to its previous iteration – with the enlarged thumbnail – and the possibility of navigating elsewhere and linking to other QuickTime movies.

The children readily understood the purpose of the Periscope with the QuickTime movies providing them with a way of finding out more about their physical discoveries. The coupling of the exploring activity with the Periscope functionality provided an intuitive and explicit way of integrating different types of knowledge.

3.2 Hypothesising – using the petri dishes and the spider

As part of the field trip the children were encouraged to develop hypotheses about the repercussions of introducing certain flora or fauna into the woodland habitat. They were given two RFID tagged items – the bootlace fungi-filled Petri dish (Fig. 9, left) and the spider in its web (Fig. 9, right). The spider, presented as a 'spider-in-

Fig. 8 Viewing the display

Fig. 9 Examining the bootlace fungi and Spider-in-Stasis

stasis', is enclosed in a ring-pull can, which the users open once they are out in the woodland habitat again by the periscope.

The children generally placed the Petri dish of fungi onto the Petri dish holder and the spider directly onto the web-like network of 'invisible' nylon thread, though this was not always the case, nor, as mentioned earlier, was it actually necessary – they served merely as a guide so that the tangibles would be placed within range of the aerial itself to affect the appropriate transformation of the Director movie. In this respect, the overall design of the Periscope can be considered to be effective. The children were able to deduce what was potentially possible with the device without needing to be led or instructed step-by-step by the accompanying adult supervisors.

One unexpected result of the 'entwined' Petri dishes design was that it affected the way the children first approached the periscope. Unlike the other technology used in the Ambient Wood project, the periscope was neither pervasive nor portable. It was a quite distinctly hi-tech 'thing' which the children 'discovered' during their journey through the woods. Often the children approached it almost warily, but with great interest – the form itself, and the different elements contained therein, seemed to intrigue them. The children generally seemed to first approach the Petri dishes that protruded like flowers or leaves from the stem of the otherwise shiny stainless steel and rubber object. The contents of the dishes stimulated discussion about what each element was and what kind of role it might play in the wood as well as where it could be found. The contents of the dishes also allowed the children to surmise whether or not they had accessed all of the information displayed within the Periscope.

4 Conclusion

The Periscope was created specifically for the Ambient Wood Project to provide additional information about the life cycle of the wood. The original intention had been to create a device that could be integrated into the woodland in such a way that it would seem to meld into its surroundings and be almost completely hidden from view. Then, in response to the children's perceptions and fascination with technology, we decided to use the Periscope to provoke, and then to intrigue and be taken notice of. Thus we moved gradually, through a series of trials and user testing, from one extreme position to its opposite polarity.

It is important to remember that the Periscope has been designed for 10–12 year old children. If the field trip was for adults, our end point may have been very

Fig. 10a,b Hypothesising with the Petri dishes

Fig. 11a,b Danielle Wilde and Ted Phelps assembling the Periscope on-site

different, just as it would have been different within any other context. What is interesting to consider, though, is how 'pervasive' or how dominant within the environment the device may have been.

When considering our contexts for design, when designing for the kitchen, for example, or a bedroom, a public place, or the underground, etc., should appliances or devices be made to fit in with the context (e.g. to be harmonious with what is already there) or should they be designed to be hybrid or even discordant?

The Periscope can be said to be a hybrid design – although distinctly high tech, the forms echo elements within a natural, organic environment – curves, leaf- and flower-like forms, even the stem being of adjustable height seems to reflect the possibility of growth and decay inherent in any biological structure.

When designing new appliances and devices we believe that it is important to move beyond previous iterations, or related examples, and to create something which responds directly to the perceived context and, where possible, to the actual context in which the device will be used. The idea of creating hybrid forms which directly reflect the environment, the intended or perceived use and the user, no matter how abstractly, can lead us to consider how to design more aesthetic, creative and unusual appliances, but which at the same time are still effective and useful for the tasks they have been designed to support. In so doing, they challenge our assumptions about how things should be while at the same time enabling us to discover new ways of how things could be.

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