Hypermedia in the Ambient Wood

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Abstract

The Ambient Wood project, carried out as part of the Equator IRC, set out to provide an augmented learning experience for children in an outdoor environment. Using a variety of devices, the children gathered information about the woodland habitats performing basic scientific enquiry and hypothesis testing.

In this paper we describe the supporting information infrastructure used in the project, focusing on how hypermedia tools and techniques were used to structure and deliver the information to the children helping to orchestrate the learning activities.

1 Introduction

In a review of the field of Ubiquitous Computing with regards mobile systems, Scholtz [22] makes the observation that in many application scenarios in the ubiquitous, mobile, proactive, wearable and context-aware research spaces, the common goal is not to provide computation on the move, but to provide information; information that is aware of the user's situation and able to deliver itself appropriately.

The Ambient Wood project was one of a number of experience projects created within the Equator Interdisciplinary Research Collaboration (IRC). The aims of the project were to create an augmented learning experience for children in an outdoor environment. The children explored a woodland using devices which enabled them to perform scientific enquiry and carry out hypothesis testing. The focus of the activities was often around the communication of information, either to remote facilitators via a walkie talkie, to another team through focused discussion or through the recording of readings and information in an electronic journal [27].

One of the challenges in such a project is structuring the information supporting the scenario and orchestrating the delivery of appropriate information to the children within the pervasive environment. With the scenario centering around information delivery based on exploration, the use of hypermedia links to connect physical locations to digital information seemed appropriate.

This paper will discuss examples of related work in this area in section 2 followed by an overview of the Ambient Wood project in section 3. Sections 4 and 5 give details of the two sets of trials and the information infrastructures underpinning them. Finally, section 6 compares the two approaches and concludes on their suitability as tools for orchestration.

2 Related Work

In this section we will discuss some related work, examining examples from physical annotation systems through to CSCW support for physical artefacts. The examples given are not intended to be an exhaustive examination of the field, but serve as representative of the issues involved in creating geo-spatial information systems.

2.1 CoolTown

The CoolTown project is an on-going research effort at Hewlett Packard that looks to extend the World Wide Web to the physical world, combining web technology, embedded web servers, and wireless communication to develop systems supporting nomadic users [18].

URIs for services and content are sensed through technologies such as infrared 'beacons', barcodes, RFID tags, and iButtons, by the devices carried around by nomadic users. These URIs define the 'web presence' of the corresponding entity, and offer a mechanism to manipulate artefacts in the real world just as they would documents on the Web. The identifiers are bound to physical or virtual resources, of which there may be many, and are interpreted by resolver services either automatically (implicitly) or explicitly through user choice, based on the application at hand.

2.2 GeoNotes

GeoNotes [11] is a system providing 'social' virtual annotations for the physical world. The annotations take the form of "virtual Post-It notes that can be read by other users passing by the physical location where you placed the note" [11]. Metadata regarding annotation use-patterns is also maintained and referenced when calculating appropriateness metrics, offering a level of collaborative annotation filtering to the service.

There are three modalities of use for GeoNotes client, reflecting the three anticipated levels of engagement with the system. Firstly, a geographically constrained active search mode offers an explicit means by which annotations can be retrieved from the annotation server. A mixed push-pull interaction exists enabling serendipitous navigation of the available annotations, where an overview of available annotations cued to situated context is made available (pushed) for users to browse and then retrieve individual entities (pull). Finally, a notification-based interaction mode exists where annotations are pushed to the client as and when they become contextually relevant.

2.3 Guide

The notion of situated context, placing users or artefacts in locations and using that placement as a primary data source, has been evident in a number of information systems in pervasive computing environments.

GUIDE [8] was a project that developed an infrastructure comprising a number of hand-portable multimedia end-systems that would provide information to visitors as they navigated a city in which wireless networking was prevalent, incorporating systems that were context-sensitive. The notion of context employed by GUIDE included knowledge of users and their environment, most importantly including their physical location.

GUIDE designed their own information model comprising objects for physical locations of interest and objects for navigational way-points, with attributes such as weight metrics for distance and means of transport. Additionally, the model incorporated information structured in a hypertext so that objects could contain references to documents, thus providing users and applications with multiple entry points into the hyperbase. The model also offered a level of dynamic adaptability in that documents within the information base could be modified at request-time, for example based on number of visits to location/current status of attraction.

2.4 WorkSPACE

The WorkSPACE project experiments with extending the notion of Spatial Hypermedia to structure information within a physical space. This work has included the integration of techniques from spatial hypermedia, geographical information systems, location-based services and collaborative virtual environments within a prototype of an information organisation tool, Topos [15]. This project uses pervasive computing techniques to distribute information to nomadic devices in the field and sense the physical situation of participants using the system as part of the information context.

Topos workspaces are sets of spatially related and placed materials such as documents, 3D models and annotations. These workspaces can be composed by linking, where the spatial context of the user is replaced upon link traversal to the new workspace, or by composition, where workspace proxies manage the interaction between the two information contexts. Resources for a particular topic or activity can be collected into spatial workplaces, and then inter-related with geo-spatial cues.

One scenario uses Topos for collaborative work support for professional landscape architects, where information about projects is held in workspaces distributed between people both on-site and back at the office, for example to assist with contextualised decision making and problem solving.

2.5 Mobile Learning

Alongside the more established area of eLearning (learning 'any time any where') [19], mLearning has developed, extending the eLearning approach to more mobile devices such as PDAs and mobile phones [10, 26]. The focus of providing any place and any time learning has largely been, to date, to consider issues of accessibility, communication and personalization.

Handheld and pervasive devices have also been used to support learning in the classroom [1, 24]. Web material has been provided via PDAs for children learning on the move [16]. Field trips have been augmented with handheld technologies [14]. Our goal was more focussed on shifting the locus of computation out of the classroom into the environments in which we live and interact [17, 9].

2.6 The City project

The City project, another experience project within the Equator IRC, explored issues of geospatial linking within a Museum environment. The project provided an enhanced museum visit experience, principally focussing on collaborative visits between people in the museum space and others exploring the museum in an on-line environment, either in a 3D model of the museum or a structured website [13]. A part of this experience involved providing navigational information to the visitors that served a number of purposes. It provided suggestions as to where the visitor might go next from their current location. As part of this, a number of pieces of information were available.

By way of example, a visitor stood at exhibit A has a link presented to them which offers the choice of moving to exhibit B. The source of the link is the physical artefact at exhibit A. The link is presented when the visitors is detected as being in the proximity of exhibit A. This was established using ultrasonic positioning systems that allowed location to be established to a reasonably accuracy of less than a metre [20]. The location was taken as a focal indicator, although on-going work is looking at refining this using orientation devices to improve the accuracy of determination of focus. Figure 1 shows the construction of such a link.

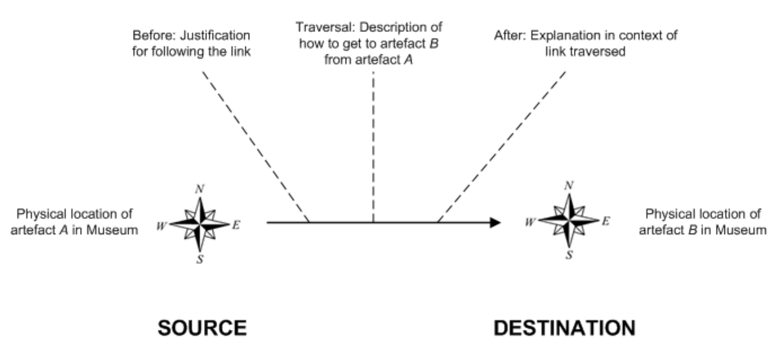

Figure 1: The navigational links of the City project.

Three different descriptions were stored for each link and presented to the visitor at appropriate points. These were:

The Before Description. This presented the visitor with information explaining why they might want to follow the link from exhibit A to exhibit B. The link author knows that the visitor is in the proximity of A and can suggest reasons for seeing B based on the visitors knowledge of A.

The Traversal Description. As the link is 'physical' in terms of its source and destination anchors, a description is provided for the users that tells them how to move from exhibit A to exhibit B. such as 'moving through the doorway at the end of the room'. The descriptions can be written relatively, with a reference starting point being the source of the link.

The After Description. Once the link has been followed and the visitor has arrived at exhibit B the author description describes B drawing relationships with exhibit A, which the author knows the visitor has arrived from.

The City project explored the use of links to connect physical locations [2]. These techniques were developed in another Equator experience project, the Ambient Wood.

3 The Ambient Wood Project

The Ambient Wood project involved the creation of a mixed reality space in a Sussex woodland. A playful learning experience was developed where children could explore and reflect upon a physical environment augmented with a range of digital abstractions. These abstractions were represented in a number of ways, designed to provoke the children to stop, wonder and learn. The Representations were designed to be 'ambient' i.e. non-intrusive where possible, with goals of augmenting the environment such as making the invisible visible, the inaudible audible.

To achieve this, a variety of devices and multi-modal displays were used to trigger and present the 'added' digital information, sometimes caused by the children's exploratory movements (wandering around a clearing), and at other times determined by their explicit actions (taking a measurement with their probe device). A field trip with 'a difference' was created, where the children discover, hypothesise about, and experiment with biological processes taking place within a physical environment.

Two major trials were undertaken of the Ambient Wood project. Moving from the first trial to the second involved a modification of the scenario to reflect and respond to observation and evaluation of the first trial. Correspondingly, the change in scenario led to a change in the underlying infrastructure. In the next sections we will examine each of the trials in term, describing the scenario and goals and looking at how the hypermedia techniques were used to orchestrate the information delivery in each case.

Figure 2: The Children exploring the Ambient Wood.

Networking in the wood was achieved through the deployment of Linux-based laptops acting as 802.11b base stations in Host AP mode, providing one flat IP-based network with coverage of the entire Wood area. The Elvin notification service [23] was used to mediate communications between the various devices in the wood.

Figure 3: Placement of 'pinger' beacons in the wood.

Location sensing in the wood was via GPS information and also hidden radio pinger beacons [20], which were placed at various points in the wood (Figure 3. The GPS and pinger receivers were attached to the children's PDA. The pinger beacons have a radial area of effect, in the case of the ambient wood trials this was approximately five meters. Children were either detected as being in range of a pinger or not, with the pingers placed to minimise potential overlap between the beacons.

As well as the technological challenges of this type of experience, the infrastructure was designed to support experimentation into student-initiated learning through the use of digital augmentation of physical interactions and actions.

4 The First Trials

The initial scenario was divided into four parts, involving two teams of two children.

Exploration Here, the children used the devices they had been given to explore an area of the wood, either a clearing, or a denser area of woodland. They took readings using the probe devices, and received information on their PDA's. They were also encouraged and guided by a remote facilitator whom they communicated with via a walkie talkie device.

Reflection in the Den After a period of exploration, the children returned to the Den area, where they were able to reflect on what they had observed and encountered in the wood using a table display upon which their probe readings and information were displayed. They communicated their findings to the other team and made simple hypotheses about how the wood might change if new species of animals or plants were introduced, or if major climatic changes occurred such as drought or flooding of the area.

Experimentation and Hypothesis Testing Having made their predictions, the children returned to the woodland habitats and took new readings and received more information that agreed with or refuted their predictions in the hypothesis testing phase.

Consolidation in the Den Having experimentally tested their hypotheses the children returned to the Den to reflect on the information they had gathered.

A more detailed account of the children's learning experience and the respective pedagogic issues can be found in [21].

4.1 The information received

During the exploration and experimentation phases of the activity the children received information through a number of different mechanisms.

4.1.1 Probe Readings

Each team of children had a probe device that allowed them to take readings of moisture and sunlight. When a reading was taken, an abstract representation of the reading was sent to the children's PDA. Figure 4 shows an example moisture reading (a) and light reading (b). The readings were converted from the actual readings to abstract readings for two reasons. Firstly, in the context of the learning experience the children were only required to get an appreciation of how moist an area of the wood was rather than specific detailed readings. Secondly, during the experimentation phase, the abstraction allowed us to 'fake' readings, simulating what might be expected if the area was flooded for example.

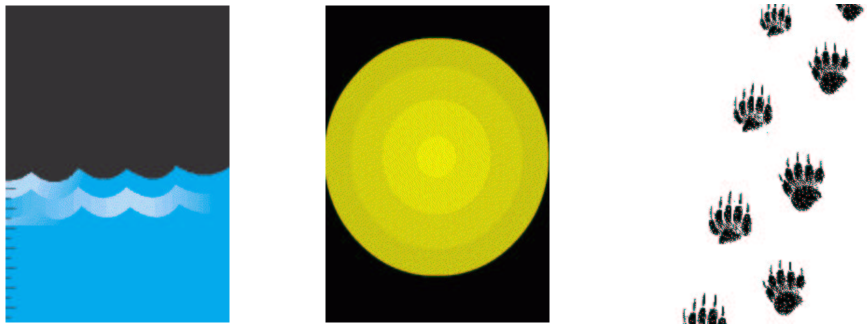

Figure 4: Image representations on the children's PDA. (a) Moisture reading. (b) Light Reading (c) received information.

4.1.2 Periscope movies

The Periscope was a stand alone device placed in the middle of the wood that allowed the children to view videos that exposed information about the habitat that would otherwise be unavailable to them [29]. The children looked through a viewing hood and could move the periscope round and tilt it up and down in much the same way as a submarine periscope might work. By moving the periscope they could select and view videos on the screen that followed the underlying themes of 'making the invisible visible' or 'bringing the far to the near'. These included animations showing the sap flowing through a tree, or the change in seasons in the wood.

4.1.3 Audio information

Moving around the different habitat areas triggered audio information to be presented to the children. There were two mechanisms for this. Ambient sounds were played through speakers hidden in the undergrowth, stretching the augmentation beyond the devices that the children carried with them. Voice-over sound files were played on the PDA, accompanying the information cards that were sent to them.

4.1.4 Information Cards

The children also received information cards as they explored. These represented information about the plant and wildlife present in the particular habitat. An example card can be seen in Figure 4(c). The information was sent to the children based on their location in the wood. To enable this, a model of the wood needed to be constructed.

4.2 The Infrastructure

To model the virtual wood we chose to use a MUD (Multiple User Dimension, Multiple User Dungeon, or Multiple User Dialogue) [3] [25]. Initially MUDs were designed as a virtual world which allows users to control computerised persona, exploring virtual environments, interact with other characters and digital artefacts and solving problem.

As MUDs have evolved, not all involve fantasy elements, nor the 'combat features,' indeed the suitability for offering support for collaborative work and task co-ordination has been previously explored [12, 6]. We chose to use our MUD[1] as a pervasive orchestrator of the activities in the physical world, with the simplified model of the MUD corresponding to the children, devices and interactions taking place in the Wood.

A number of factors suggested the suitability of a MUD architecture, such as:

Metaphor of real life. In a MUD, people and things exist in a place, and people interact with their environment as they would in real life.

The programming model. The object-oriented, event-based programming model enabled us to attach behaviours to virtual representations of real-world objects, and model the state changes on a per-object basis.

Virtual scenario enactment. Because the world model represents the physical scenario, some debugging of the scenario could be carried out within the MUD before deployment in the actual wood.

The facility to intervene. The virtual model can be changed explicitly from within the MUD, allowing us to affect events in the physical world.

Real-time extensibility. The MUD can be adapted while it is running, allowing the creation of new virtual objects, or even locations allowing the possibility for adapting the scenario and 'game logic' during the experience.

Centralised orchestration. For the initial phase of experimentation at least, maintaining a central model of all of the state of the various sensors, tangibles and real-world objects facilitated scenario engineering.

Post experience decomposition. Through maintaining extensive event logs, different parts of the scenario can be analysed, or even replayed, virtually.

The MUD held a simplified model of the wood. The MUD model contained rooms representing locations in the wood corresponding with pingers, characters representing the children in the wood, objects representing the various devices in the wood such as the speakers and the periscope, and scripts containing the information that was transmitted to the children.

[1] Our MUD was a derivative of LPMud, named after the original author, Lars Pensjö. The MUD mechanics are programmed in an object-oriented C dialect called LPC.

The delivery was information ‘push’, based on event triggers. As children came within range of the hidden pinger beacons, the MUD reacted by placing their character representations in a room in the MUD representing the location in the wood. Scripted links in the MUD were triggered by this arrival, leading to information being displayed or played in the wood, either in the form of the audio heard through the hidden speakers, or images and voiceover information on the children’s PDA.

The MUD information model is the hyperstructure with rooms in the MUD functioning as source anchors; the information contained in the rooms being the destination anchors. The source anchors are matched when the children are present in the room in the MUD, i.e. they are at the physical location in the wood modelled by that room. The coupling between the physical wood and digital model is achieved through the pinger technology. There is no selection action on the part of the children; the links are followed automatically on arrival at a new location. In essence, the children ‘walk’ the hypertext.

An example link is shown in figure 5. Each link had three pieces of content associated with it. Initially a sound was played through the speakers in the wood, followed five seconds later by an image and accompanying voice-over on the PDA.

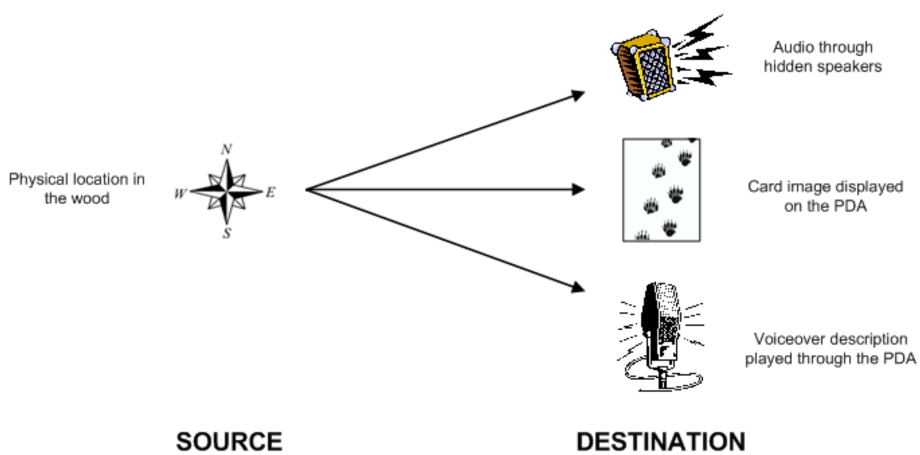

Figure 5: The links held within the Ambient Wood MUD model.

The scripted information was organised to build up the information model for the children. The first time they entered a location they might be presented with information about plants, the second time, information about insects that made use of the plants as food or habitat. Prior knowledge of what the children had experienced was used to orchestrate the delivery of subsequent information.

The links were in effect contextual, with the context being the current state of the MUD model. Links were automatically traversed when the children arrived at the source location. As such, link selection was made automatically by the MUD based on the current context and the link was not visible to the children, their awareness being limited to the presentation of the destination either as an image on the PDA or audio. A side effect of the link enactment is the updating of the MUD model. This in turn can affect the availability of links, as the children's knowledge builds through the experience. Where there is more than one link available from a location the MUD chooses which to follow. The simplified orchestration involved cycling round the available links in sequence.

The information was learner-driven to the extent that the children accessed the information by moving around the physical space to discover it.

4.3 Post-visit experience

One of the goals of the project was to allow the children to reflect on their experience in the wood when back in a classroom setting. During the trials, detailed logs were recorded of all of the children's activities. Each time the children received information, either explicitly through probing the environment, or implicitly through receiving images and voice-overs, the information was recorded along with their location in the wood.

A hypermedia journal system [27] was created that allowed the children to review their experience using a simple web interface when back in the classroom environment. Having selected their trial, the journal system processed and consolidated the event log to produce a hypertext that narrated their experience. Simple narrative techniques converted key events into episodes of the story, recreating the images and sounds that they encountered and providing a tool for personal reflection, or indeed for the children to use to explain their experience to others.

4.4 Reflections

A number of issues were identified in the analysis of the first trials of the ambient wood.

The locations representing the source anchors of the links were not obvious to the children as the trigger was a hidden pinger not necessarily in the proximity of an obvious landmark. This often resulted in either a 'metal detector' style search for information where the children wandered around staring at the PDA waiting for information to appear, or alternatively, the children were surprised by information appearing on the PDA with seemingly no conscious action on their part. This also inadvertently focussed the children too much on the technology they were carrying with them, and less on the flora and fauna which they were supposed to be studying. The second trials would seek to address this technological focus.

A second problem was the disconnection between the information they were receiving and what they could actually observe around them. They might receive information about nettles when approaching a nettle patch, but a subsequent return would provide information about butterflies nesting on the nettles when none were visible to the children. This arises due to the limited contextual knowledge of the children's surroundings, principally being only their location and some prior knowledge of the environment on the part of the scenario construction. Another aspect of this occurs through the scenario goals. In the second phase of experimentation they children can virtually 'flood' the wood area and use their probe tools and information gathering to explore the effects. While we can modify the probe readings to give artificially high moisture readings, and send the children information about reeds and marshland, this does not correspond to what they are observing with their own eyes, as the wood appears the same as the one they explored previously.

A final problem with the first approach was with the actual authoring of the material. Because the links were scripted into the MUD, some specialist programming skills were required to translate the requirements into the links. For the second trials we wished to place the authoring ability in the hands of the scenario creators themselves.

5 The Second Trials

The revised scenario was also divided into four parts, with two teams of two children.

Exploration The children again used the probe devices to explore either the clearing area or the dense woodland area. They also had a 'horn' device which, when triggered by the hidden pingers, allowed the children to listen to sounds that would normally be inaudible. These included abstract representations of processes such as root uptake and photosynthesis. As in the first scenario they communicated with the remote facilitator using the walkie talkie, but here the scenario was modified with the remote facilitator sending the children information in response to the information the children provided via the walkie talkie. Rather than information being 'pushed' at the children, the information was delivered on request in the form of information and question cards. These allowed the remote facilitator to orchestrate the enquiry in a structured way, with the PDA becoming more of a log book of the children's findings. The exploration phase focussed on the plant life and processes in the habitat.

Reflection in the Den The children then returned to the den and described to the other team the habitat they had explored. To enable them to do this, a visualisation of the information they had gathered was projected onto a map, with icons representing the various readings and pieces of information. The children could interact with the map by selecting information for viewing and describing it to the other team. The two teams were then told that they would swap habitats for the next phase and had to predict what creatures might live in the habitats.

Experimentation and Hypothesis Testing Having made their predictions, the children returned to the habitats and investigated the wild life present. The horn device was again used to provide clues as to the animals that live in the area, reinforced by information and questions from the remote facilitator.

Consolidation in the Den Having experimentally tested their hypotheses the children returned to the Den and again, reflected on the information they had gathered.

The second trials also included a post-visit classroom session where the information collected was re-used within a classroom environment for activities such as constructing food webs.

5.1 The information received

5.1.1 Probe Readings

The probe device was retained for the second trials, with slight modifications to the abstract representations for clarity.

5.1.2 Audio information

The speakers were removed from the second trails, in order to experiment with a different mechanism for audio delivery. A new device was constructed called the ambient horn. As the children moved around the space, the horn device would occasionally flash its lights to indicate that it had received an 'inaudible' sound which it would like to amplify for the children to hear. These inaudible sounds were abstract representations of plant processes, encouraging the children to make the connection between processes that they learn about in the classroom such as photosynthesis, and the physical environment of the wood.

5.1.3 Information Cards

The children still received information cards as they explored, representing information about plant and wildlife but rather than the information being sent to the children based on their location in the wood it was sent by a remote facilitator in response to discussions over the walkie-talkie. The set of information was extended from simple information cards to include question cards that the remote facilitators could send to prompt the children towards new discoveries or conclusions

5.2 The Infrastructure

Adaption of the scenario in the second trials moved away from the MUD model of the wood towards a more facilitator-provided model of the information. The children reported their observations to the remote facilitator who had a variety of information at their disposal. They could send this information to the children's PDA to log their findings, pose questions, or engage in discussion about the nature of the findings.

A sculptural hypertext approach was adopted to help scope the information for the remote facilitator [4, 28]. In his seminal paper on sculptural hypertext [4], Bernstein described each node in the hypertext as having sets of requirements and assertions. Nodes can only be read if their requirements are met by the current state of the reading. Once read, a nodes assertions are made leading to a new reading context which might make new nodes available, or previously available nodes no longer valid.

This approach was applied to the information being delivered to the children within the Ambient wood. Each of the information cards had a set of assertions and requirements associated with it. Similar to the approach using the MUD, the system kept track of the information presented to the children by keeping a list of the assertions made. The remote facilitator was presented with a list of cards whose requirements were met by the assertions on the list. As each card was sent to the children, the new assertions were added to the list. This led to more information cards becoming available as their pre-requisites were met. For example, once the children had received information about a particular plant and taken moisture and light readings an the area, a question became available for the remote facilitator which asked why the plant might grow in that area. In this way, the sculptural hypertext served both to help the facilitator deliver information that was appropriate in the current context, and also built up the children's knowledge in a structured manner.

5.2.1 The Facilitator Tool

A facilitator tool was created to help the remote facilitator to orchestrate the delivery of appropriate information. The interface can be seen in Figure 6. The list of titles down the left hand side of the screen are the currently available information cards. In order to help scope the cards, the facilitator has a number of check boxes (bottom left) which can be used to scope the current set. For example, in the first exploration phase the children were asked to investigate the plant life in the habitats so cards relating to animals could be removed.

When one of the card titles is clicked on by the facilitator, it is previewed in the space in the centre of the interface. The facilitator sends the card to the children using the button below the preview. This action effectively authors a link between the child's current location and the information card sent by the facilitator (see Figure 7.) The initial action is for the image of the card to be displayed on the PDA of the child. The author link can be re-used later in the experience in the Den session, where the links are placed on a map table for the children to use to discuss their exploration.

The graphic of the PDA on the right of the interface displays whatever the children are currently looking at on their PDA; this provides feedback to the remote facilitator on the children's current activities. Finally, the text box at the top of the interface enables the facilitator to create new cards if required. The cards will contain a default information or question icon, along with the text entered by the facilitator.

The set of cards are constructed along the lines of the card shark cards pro-

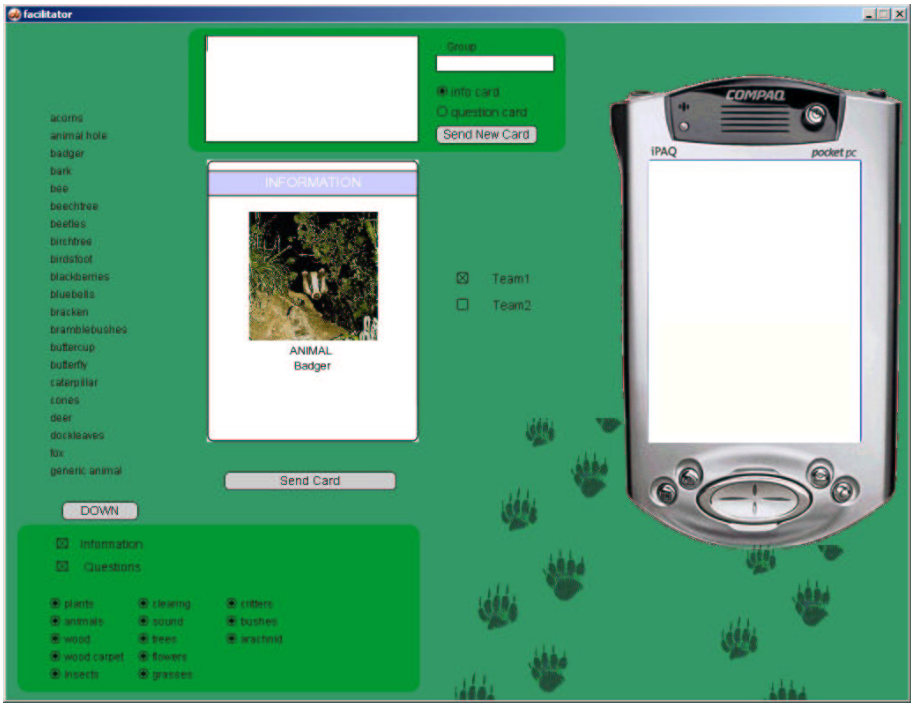

Figure 6: The Facilitator interface.

posed by Bernstein [4] where each card is accompanied by a set of requirements and a set of assertions. The facilitator tool maintains a blackboard of context information. Each time an information card is sent to the team, the assertions are placed onto the blackboard. The current list of available cards contains only those cards whose requirements are met by the information on the blackboard. Figure 8 illustrates this. The bee card has no requirements so is available from the start. When the children report seeing a bee, the remote facilitator selects the card and sends it to them. Once the card has been sent, the assertion 'Bee' is placed on the blackboard. The blackboard now meets the requirements of the question card shown in Figure 8 so the question card is added to the available cards list. The facilitator is now in a position to prompt the children with the question about how bees might benefit the flowers based on the knowledge that they have already received information about bees.

In this way, the sculptural hypertext approach presents a simple orchestration mechanism for the remote facilitator to build up the layers of the children's knowledge based on their prior observations.

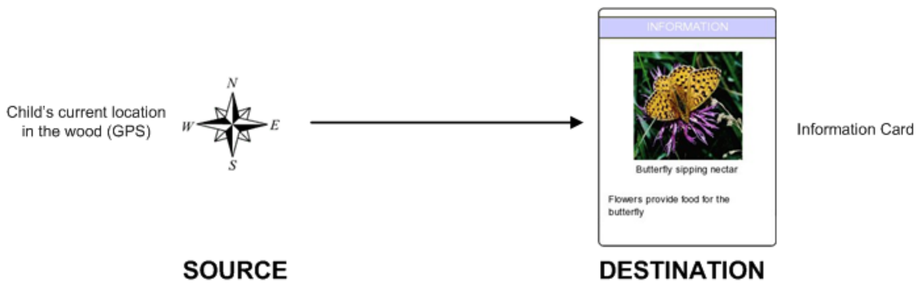

Figure 7: The links created by the facilitator.

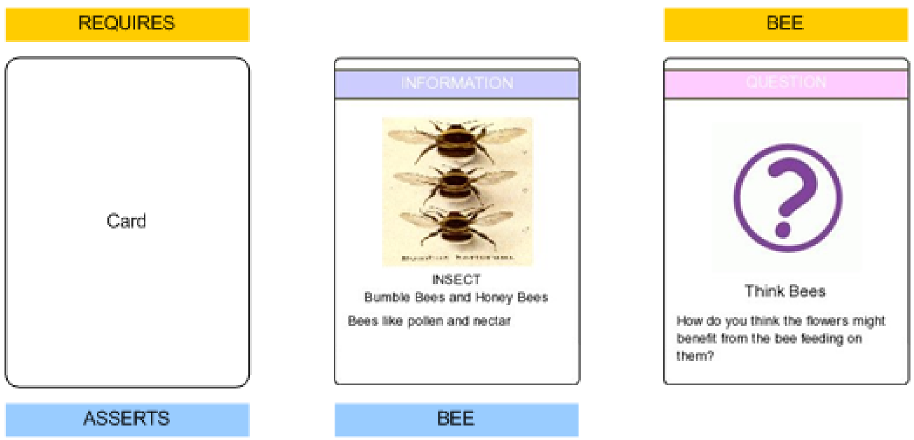

Figure 8: Example cards with requires and asserts metadata.

5.2.2 Information Authoring

Previous work has looked at the issues of authoring sculptural hypertext in the domain of hypertext fiction [5]. Our approach on the ambient wood project was to put the tools into the hands of the scenario builders.

The cards were described on a Wiki collaborative authoring page. Wikis are Web-based applications in which content can be created collaboratively by using just a browser [7] [2]. For each card information was given for a name, type, title, description, group, asserts, requires and image. The types were Information, Question, Probe and Sound. Cards were produced for each of the probe readings and Sounds generated by the horn. This allowed the probe reading cards to make assertions like 'Wet' or 'Dark', which in turn could be requirements of other information cards. Where images weren't supplied, default information and question icons were added to the cards. The group information was used to allow the facilitators to reduce the size of the list by scoping according to the different phases of activity.

[2]TWiki is open source, and is available from http://twiki.org/

Once the Wiki had been populated with information, simple scripts generated the card images and an accompanying XML file containing the card information which could be used by the facilitator program. By using a Wiki, the scenario builders only had to edit and maintain a simple text file enabling quick adaption of the content and ease of re-use should the scenario change dramatically. The sculptural approach also reduces the need for explicit link authoring of the material. It is possible however for cards to be described that are never active during the experience due to their requirements never being asserted by other cards. More complex analysis tools would help content creators to overcome these issues.

5.3 Post-visit experience

Building on the informal classroom activities of the first trial, the second trial more explicitly sought to connect the activities in the wood with a formal post-visit classroom session. Printing the card digital representations of the information provided a simple way of producing tangible physical artefacts for use in the classroom. These were used by the children in new learning activities such as the creation of food webs, with the aim being to provide a connection between what they had viewed in the wood, represented by the cards, being connected to the physical cards manipulated in the classroom session. Prototype tangible interaction devices based on RFID tag technology are also being assessed and the evaluation of the post-visit classroom activities is currently underway.

5.4 Reflections

Detailed evaluations were carried out on the effectiveness of the ambient wood as a learning environment and these are described more fully elsewhere [21]. Here, we will focus on reflections on the supporting infrastructure and tools.

One of the biggest benefits in moving from the scripted MUD to the sculptural hypertext was the ease with which the scenario builders were able to construct the information content. The hard coding of the information into the MUD required some specialist programming skills which added an additional stage in the revision cycle for the content in the first trials. By moving to a web based authoring system for the second trials the scenario builders had increased ownership of the authoring process.

The sculptural approach gave greater flexibility for unplanned discovery as the facilitator could react to the children's exploration even creating additional information on the fly if necessary. Each new card would then be added to the system; Hypermedia authoring in the field (quite literally). The links became persistent so that they could then be re-used in the Den sessions or indeed in the post-visit classroom sessions.

Perhaps due to the new way of authoring, the requires and asserts fields tended to be quite simple and under-utilised. This lead to the information structures tending to be quite flat and mostly hierarchical even though sculptural hypertext is capable of supporting more complex and hypermedia patterns such as cycles, webs, split/join etc. More work is needed on the authoring tools to help the scenario builders better exploit the potential of the system.

6 Conclusions

In this paper, we have explored two quite different approaches to the orchestration of a learning experience using hypermedia techniques.

The MUD model readily supported the pinger locations of the first trials, with the room based metaphor appropriate for locations based on either being in range or not. More complex spatial models would not have added anything to the scenario in this case. The second trials, focusing less on information triggering, used the GPS locations more explicitly, with the pingers only being used to trigger sounds on the ambient horn device.

As in the City project, the ambient wood trials both dealt with links from physical locations to pieces of information. In the first trials the links were stored in the MUD, with the source locations being selected by the children coming within range of a hidden pinger. The resultant automatic link following led to information being presented to them via audio or images on their PDAs.

In the second trials, two types of hypermedia links were present. The first were pre-authored sculptural links created as part of the scenario construction process. These were used as part of the remote facilitators tool to help them to orchestrate the activities and respond to the children's comments via the walkie-talkie. The second type of link was created during the trials as the facilitator sent information cards to the children. As in the first trials these had physical locations as their sources, (the children's current location) and information as the destination (the card sent by the facilitator). These links persisted during the trails in the logging mechanism enabling them to be re-used during the reflection phase in the Den. The flexibility of this link creation process enabled the facilitator to create their own destinations (i.e. generate new information cards).

The degree of automation differed between the two trials. In the first case, the information orchestration was entirely automatic, with the pre-scripted events in the MUD leading to the presentation of information during the experience. In the second trials, responsibility for the orchestration fell to the remote facilitator assisted by the facilitator tool. The lack of automation was offset by the increased flexibility to adapt the scenario and indeed content, on the fly.

A focus of the development of the Ambient Wood project was to place the tools for construction of the experience into the hands of the experience builders rather than the systems experts. This partly involved providing improved tools, but also included adoption of new authoring techniques, such as sculptural hypertext, which provided more fluid environments for structuring information.

Experiments in the Ambient Wood have highlighted two approaches for the use of hypermedia in the orchestration of such experiences both with strengths and weaknesses. In future evolutions of Equator experience projects we will continue to explore both approaches and indeed the interplay between them.

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