# ORIGINAL ARTICLE

Giulio Iacucci · Juha Kela · Pekka Pehkonen

# Computational support to record and re-experience visits

**Abstract** Information technology research has mainly focussed on supporting visitors with guides, whilst a lot of opportunities for the development of technology for collecting, manipulating and re-travelling through material from the visits remain unexplored. On the basis of observations from a specific setting, we have developed prototype technology to combine multimedia content with position information. In particular, we developed mobile support to record and organise multimedia using the walked path in order to preserve more of the experience of the visit. We created tools to edit and store multimedia paths. Additional components make it possible to configure a mixed-media environment to navigate a multimedia path, using such physical interfaces as gesturing, and link the recorded media to other artefacts. When discussing field observations of current practices and prototype trials, we investigate what kind of functionality is needed to support the whole activity of collecting, manipulating and playing multimedia content in combination with position information.

**Keywords** Recording and visualising visits · Handheld devices · Multimodal interfaces · Location-based information · Field trial

## 1 Introduction

Visiting a place of interest is a fairly common activity in a variety of work and leisure settings. During these visits, places are experienced and different objects and media are collected. This material is integrated at a later time in a work or home environment and used in various ways, for example, to "re-travel" through the visit. Information technology research has mainly focussed on supporting visitors with guides, whilst a lot of opportunities for technological development for collecting, manipulating and re-travelling through material from the visits remain unexplored. Additionally, current visiting practices remain relatively unexplored. Careful observations of everyday situations could provide important indications for the development of technology, especially with the increasing availability of personal electronics. Our contribution in this problem area is twofold. Firstly, we report on observations of visiting practices in a specific setting, advancing our understanding of how material from visits is currently collected and manipulated. Secondly, we have developed prototype technology and organised field trials to investigate the requirements and opportunities for computational support when combining multimedia content with position information. In particular, we investigated two aspects: the ways in which position information and related visualisations can be useful and what kind of functionality is needed to support the whole activity of collecting, manipulating and playing multimedia content combined with position information. The latter includes discussing a system architecture in terms of computational components, what activities they support and how they relate to the rest of the work environment.

### 1.1 Methodology

The study was carried out in a specific setting, the Academy of Fine Arts in Vienna, as part of the IST project, Atelier [1]. The method we adopted is one of iterative prototyping and design, grounded in the observation of current practices. The overall aim of the Atelier project is to develop an ubiquitous and mixed-media environment for inspirational learning. In

G. Iacucci (✉) · P. Pehkonen
Department of Information Processing Science,
University of Oulu, P.O. Box 3000,
90014 Oulu, Finland
E-mail: giulio.iacucci@oulu.fi
E-mail: pekka.pehkonen@oulu.fi

J. Kela
VTT Electronics, Kaitoväylä 1,
P.O. Box 1100, 90571 Oulu, Finland
E-mail: juha.kela@vtt.fi

particular, the focus is on the project-oriented design work of architecture students, in which visits to various remote sites are frequent. The analysis in this paper is based on two types of evidence: an observational study of current practices and field trials of the prototypes. In the first phase, we observed how students visit remote sites and manipulate collected materials in their work environment. Concurrently with the observations, we developed computational components that were the object of several trials and iterative development. The Atelier project also considers other aspects of the students' project-oriented work and provides physical and digital infrastructures for a variety of components [2]. The components we developed to support the recording and re-experiencing of visits make use of the Atelier infrastructure, e.g. a shared hypermedia database. The paper will have three sections. Section 1 will provide observed episodes from several student projects (prior technology interventions) in the first half of 2002, depicting the current practice of visiting and integrating material from visits into the work environment. Section 2will describe the computational components that we have developed and how they support the process of recording and re-experiencing visits. In Section 3, we describe the field trials and discuss the evaluation of evidence for the concept and system architecture.

## 1.2 Related work

A recent work by Büscher et al. [3] has addressed, with a more comprehensive approach and mature technology, the support for flexibility, mobility and collaboration for landscape architects. They present one mobile appliance, the "sitepack", and two room appliances (a panel with pen interaction and a table with a horizontal display area). All three appliances run the Topos software in order to share workspaces and documents. The sitepack provides ways to index photographs and sound notes with global positioning system (GPS) coordinates, and is also designed as a remote collaboration tool. Although Büscher et al. [3] have developed a more comprehensive computational support, our prototypes have at least two distinctive qualities. Firstly, our applications are designed to record a walking path at a remote site (drawing lines using the visitor's body) and use a picture, sketch or map to visualise it, along with multimedia recordings. Secondly, we have developed a navigation environment where people can re-travel through material from visits using multiple projections, gesture control and physical artefacts as interfaces. Location-based applications have, otherwise, mostly been the object of research for tour guiding purposes. Davies et al. [4] developed GUIDE, where the systems obtain information through a high-speed wireless network deployed throughout the target city. GPS has also been used for tour guides and other recreational applications [5–7]. Grinter et al. [8] present a field study of an electronic guidebook in a museum, which considers how individual and group-ware features were adopted in different visiting experiences. In [9], the "Shopping Jacket" uses two positioning devices, GPS and "Pingers" (used to signal the presence of a shop and to indicate the type of shop and its website). In [7], infrared beacons, radio-frequency ID tags or barcodes are attached to people, places and things to create a hyperlink between a physical entity and a web resource. These hyperlinks rely on commonly available wireless mobile devices to help users automatically access services associated with physical objects. Location information has been used to create a location-based information system such as GeoNotes [10]. In this case, the "user is allowed to enter/upload information, to which the system automatically allocates a latitude-longitude coordinate. Later, the same user, or some other user, can access that information (again via their wirelessly connected terminals) when they enter the place."

## 2 Vignettes from current practices

In the projects at the Academy of Fine Arts, groups of architecture students have to work out designs of interventions for remote physical locations, which are visited frequently throughout the project. Experimenting with several representation techniques, they concretise solutions, which are presented and discussed in weekly feedback meetings with staff and external reviewers. The diversity of the material and media is an important characteristic that is exploited in the work they produce. Students work with and produce text, diagrams, cartoons, video, sketches, screenshots, virtual models and prototypes—material of different degrees of abstraction and of different scale and materiality. In the next paragraph, we provide brief episodes that describe ways in which students currently manipulate materials from visits.

### 2.1 Selected episodes

**Visualising interviews for the design of an inner courtyard** This project dealt with redesigning an inner courtyard. In the first phase of the project, the student interviewed people living in the area. She represented each person with a list of keywords and symbols on a map. Each list had a pin and a thread connected to another pin on the map showing where the person lived. Figure 1 shows how, when presenting the model, she used electronic devices to augment her diagram; a digital camera and an audio recorder playing parts of the interview.

**Photographs and models from a visit to the Alps** A group of eight students worked on a project to design interventions in a valley in the Alps near the Italian–Swiss border. All the students were developing their own

**Fig. 1** Digital pictures and recorded audio in a diagram



designs but had to coordinate the project so as to create a coherent intervention in the valley. At the beginning of the project, the group visited the site and took pictures of the valley at different times of the day. A student worked on the paths and underground rooms inside a small mountain. When he returned from the visits, he built a model of the mountain. When describing his project and the visit, he showed, on the model of the mountain, in which location and in which direction the pictures had been taken. The pictures were taken from a particular place at a specific time of the day, and were attached to the wall near drawings of the mountain (Fig. 2).

**Visiting stadiums around Europe** This project was aimed at producing new concepts for "a stadium in the city" for the European football championships of 2008 in Austria and Switzerland. An excursion was organised to London, Lille and Paris, where students had the opportunity to visit eleven different stadiums. The teaching staff used additional "constraints"; roles, observational techniques and timing, to facilitate the collection of material. Different roles were assigned to the students. Each of them belonged to one of four groups; context, construction, hybrid and conversion. They also assumed specific roles, from recording all kinds of liquids (e.g. drinks, irrigation) and machines and focussing on the penalty kicker, to recording guiding systems and colours and looking at "seats and smallness." This helped them focus on particular aspects of the stadiums and their environments. Another instruction that the students received was to use a par-

ticular rhythm, such as, for example, taking a picture every 30 s from the moment they stepped out of the underground until they arrived at the stadium. The tools that were used during the visit were analogue and digital cameras, camcorders, MD sound recorders, maps, diaries and notebooks with records of the journey, and to which the objects were attached. Pictures were taken in the part of the city surrounding the stadium and inside the stadium from different points (it was important to have different perspectives; those of a player or an observer). Pictures were taken in a particular temporal sequence, such as approaching the stadium or documenting the stadium filling up. Additionally, the recording of sound was tied to particular moments, such as, for example, when the stadium observed a "minute of silence" before the match began.

When the students returned from the trip, they re-travelled through, for example, photographs, by arranging them on tables. The pictures were explained to another group member and their relevance was discussed or anecdotes were told as stories (Fig. 3a). Material collected during the visit was used in presentations, for example, a diary containing text, stadium tickets and maps augmented with barcodes (Fig. 3b).

## 2.2 Emerging issues

Visiting is an important activity in architectural design. Students and architects might visit several sites during one project for the purpose of comparison or inspiration. The analysis of the observations showed how

**Fig. 2** Photos on the wall and the physical model showing where they were taken

**Fig. 3 a** Some of the photos from the visit to the stadium are arranged during storytelling. **b** A diary is used to navigate through pictures of the visit with a barcode reader

visiting is, first of all, experiencing a place and collecting objects and media. These, integrated in the work environment with other artefacts, constitute the material for developing and objectifying the designs. While manipulating the collected media, some contextual information was important, e.g. the place where the media and objects were collected, the direction of the picture, the time of day, etc. More importantly, pictures carry a meaning for the person who took them. We often observed storytelling situations that revolved around pictures of visits and other objects. The students or architects narrate important impressions of the situation and their relevance for the design project. Sharing the experience of the visit is an essential part of the group work in the architectural design projects we observed, and it facilitated the creation of a shared understanding of problems. The implications, we inferred, were the opportunity for providing mobile support to record and organise multimedia by using the walked path to preserve more of the experience of the place. Moreover, we envisioned the opportunity to create a tool to navigate and manipulate material from visits. Finally, the need to provide ways to integrate and link digital media from visits with the work environment became clear.

## 3 Developed components and usage scenario

The usage scenario we set out to support is of architecture students visiting a remote site to collect material for a design project. One or more visitors perform a path

walking. The path is recorded using a time and GPS trace. These are created by a mobile application, *eDiary*, while visitors take pictures, videos, sounds and text notes along the path. Back in the work environment, the media files and the GPS log can be easily stored with an application, *PathCreator*, in a hypermedia database, creating a navigable and editable media path, called a *HyperDocument* of the visit. Visitors can load a picture as a map on which the path is visualised. Using multiple projections and physical interfaces, the visitors can re-experience the visit, linking the media material to other physical artefacts (posters, models, objects, etc.).

### 3.1 Recording, editing and storing a visit

We have developed several components to support the scenario above (Fig. 4). The eDiary is a mobile application that runs on an iPAQ, which creates a Hyper-Document containing a log of time and GPS traces, using a CompactFlash receiver card. The HyperDocument contains HyperNodes for each position; these are created every 5 s. The GPS coordinates and time log are saved in the meta-information of the HyperNode. The interface of the eDiary displays the current GPS coordinates, provides a file menu to save the HyperDocument and has three buttons: start recording, stop recording and, with an additional button, users can record the direction of a photograph using VTT's Soap-Box as an electronic compass. SoapBox *(Sensing, operating and activating peripheral box)* is a light,

**Fig. 4** Recorded media, GPS trace and the PathCreator in the Atelier environment
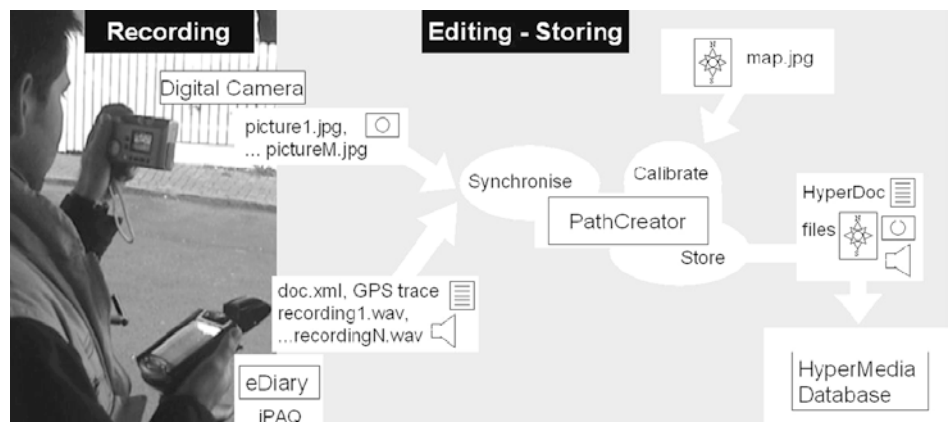
matchbox-sized device with a processor, a versatile set of sensors and wireless and wired data communications [11]. With the iPAQ, users can also record sound or write text notes. These files, together with the created HyperDocument of the visit, containing the time log and the GPS trace, can be saved on an SD (secure digital) memory card. When returning from a visit, the user connects the digital camera and the SD memory card to a PC running PathCreator. This application is used to combine and synchronise the GPS trace (HyperDocument) with the multimedia files (pictures from the camera, sound files and text files). PathCreator assigns each file to the HyperNode with the nearest time (the clock of digital recording devices needs to be synchronised with the eDiary). Moreover, it provides loading and GPS calibration of maps on which the visit can be visualised.

Any digital picture, e.g. a map, a scanned sketch or a photograph can be loaded as a background image on which the path needs to be calibrated, though only for the first time (Fig. 5). This is done by moving, stretching and compressing the path on the map until it fits the actual path.

After this, the GPS coordinates of the corners of the picture are stored as map meta-information, and the next time the map is chosen, the new path is visualised correctly. As an outcome, the PathCreator stores a navigable media path (a HyperDocument of the visit and relative files) in the database. We have developed several versions of the PathCreator, which differ in the way multimedia files are combined with the log and GPS trace. Only in the first version did the users have to press a button in the eDiary each time they were taking a picture or recording a sound. This was later replaced by assigning media to the position according to the time log. In the current version, even if the clock of the digital camera was not synchronised with the eDiary, this can be done afterwards by selecting a multimedia file and a node, and all the rest of the files of the same type are redistributed in the nodes accordingly. The current

version makes it possible to visualise a group of paths on an overview map displaying each path as a point. The PathCreator also provides a way to manipulate a HyperDocument (path); HyperNodes can be added, files can also be loaded manually to a specific node and meta-information can be edited.

### 3.2 Configuring the interfaces and re-travelling visits

We have developed visualisation and navigation applications that can be used through configurable physical interfaces (Fig. 6).

The path can be visualised on a map in a 2D or 3D environment. The visit is also navigable on a web page as an interactive graphic representation (*HTMLVisualiser*) displaying and playing all the media files with a web browser, and also through a mobile PocketPC. A more immersive arrangement for a closed environment and multiple projections can be organised using the *3DNavigator* and *MediaPlayers*. Figure 7 illustrates the *3DNavigator*, where users can navigate the path in a 3D environment, using the map as a ground texture. The nodes are also placed at different heights according to the altitude, and an additional visualisation mode makes it possible to deform the ground texture according to the sensed altitude. A compass is displayed and shows the current cardinal points. The navigation is performed either by moving freely in the space or moving from one node to another. The multimedia objects contained in the current nodes are listed on the right and can be opened and played on a MediaPlayer in additional projections. Several physical interfaces can be used either to navigate the media path or to play a specific multimedia file: gesture and tilting interaction, infrared remote controls, RFID tags, barcodes and touch sensors. These physical interfaces can be used to link physical diagrams and physical models to the collected media. A gesture recognition system based on VTT

**Fig. 5** The PathCreator loading and calibrating a map for the path; *solid circles* indicate the presence of media in the nodes
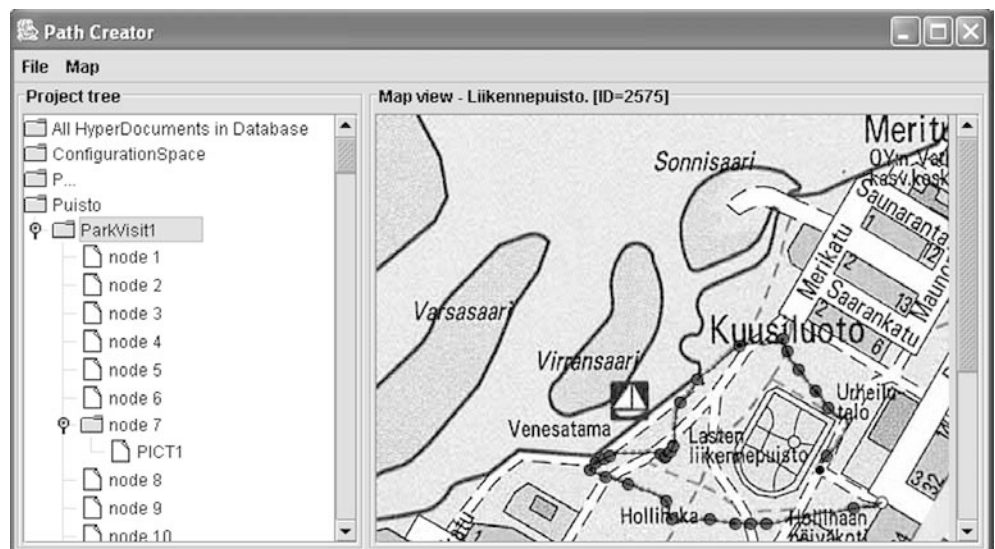
**Fig. 6** Physical interfaces can be configured to re-travel visits using multiple projection screens
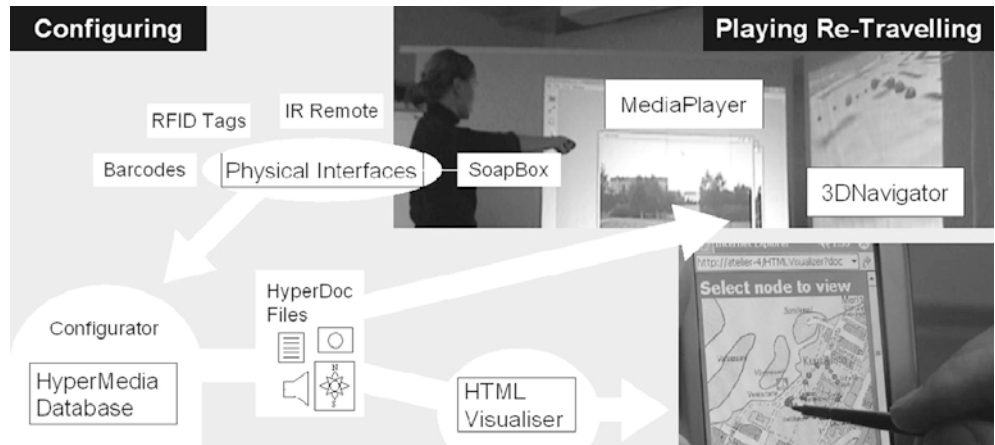


Electronics' SoapBox makes it possible to interact with the system by means of user-configurable gestures and tilting.

The hand gestures are detected by the acceleration sensors built into a SoapBox. The measured signal values are wirelessly transmitted from the hand-held SoapBox to a receiver that is connected to a Windows PC using a serial connection. All signal processing and pattern recognition is performed by the PC. The system is capable of detecting the tilting of the device; however, the main focus is on discrete gestures, i.e. short 3D meaningful movements that invoke actions [12]. Recognition results can be mapped to different control commands and transmitted using the Atelier infrastructure. Figures 8 and 9 show one of the configurations of physical interfaces that we used, with MediaPlayer1 playing objects contained in nodes and MediaPlayers 2 and 3 playing media objects associated with tags or barcodes. A physical input event can be associated with digital navigation functions:

– To move between nodes containing media (solid circles): *next*, *previous*

– To play all media contained in the node on the MediaPlayers: *open*
– To move freely in the 3D environment (e.g. to reach a bird's-eye view): *moveForward*, *moveBackward*, *moveUp*, *moveDown*, *rotateRight*, *rotateUp*, etc.

Physical interfaces can also be utilised in the interaction with the MediaPlayers:

– To skip or close media files on MediaPlayer 1 on which the content of nodes is played: *next*, *previous*, *close*
– To play a specific file on additional MediaPlayers, e.g. when a barcode is played

These configurations are performed with a dedicated application and are stored in the database from where they can be edited or loaded.

## 4 Field trials

We organised three different trials to evaluate the prototypes. The types of trials ranged from laboratory tests

**Fig. 7** The recorded path is visualised over a map and in a separate 3D view
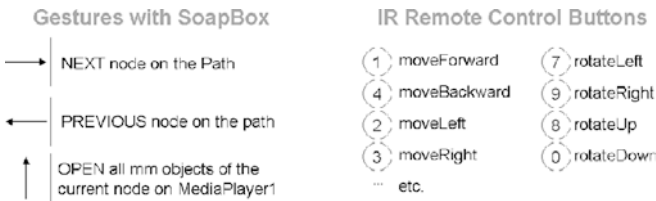
Fig. 8 A possible configuration to navigate in the 3DNavigator and open objects in nodes



Fig. 9 A possible configuration to interact with MediaPlayers

to actual field trials in real projects. The trials accompanied the development of the components for more than one year, allowing for iterative prototyping. All of the trials were aimed at evaluating the concept and system architecture by refining requirements and components. Each trial covered the whole process of visiting/recording, editing/storing and playing/re-travelling (Figs. 4 and 5) and ended with a feedback session. A particular objective of the trial in the next paragraph was to evaluate the viability of our solution in supporting the whole process: the capability of the GPS trace to reproduce a walked path, the feasibility of calibrating the map with the path in the PathCreator and the capability of the navigation to provide support for presenting the visit. The following trials on which we report are additionally aimed at uncovering situations that would ground the usefulness of the concept. However, the two latter trials revealed more about the viability of the solution, revealing serious limitations of the technology.

### 4.1 Visiting a park to be renovated

We asked a landscape design student to select a location to be visited. She selected a park in the city centre that was likely to undergo renovation. The student was taking photographs while another person was operating the eDiary. She recorded two paths, one with 20 photographs and eight recorded sound notes, the other with seven photographs and four sound notes. While walking, she focussed on the current lighting system, the views from particular points, e.g. from a height in the centre, skylines around the park or the choice and status of particular plants.

As an example, during the path at one position, she recorded the following note with the iPAQ: "these trees could be removed to improve the view of the sea." Walking towards the sea, she recorded: "it would be nice

to see from the shore how the park looks (with and without the trees)." Notes on plants in particular positions in the park were also recorded: "there are poplars on the shore; they might not be the best plants nowadays, but they bring their own character." Again, "this plant is not in good condition; it could be made more impressive." As Fig. 10 (right part) shows, to navigate the visits, we organised two back-projection screens, a board on which to hang physical diagrams and sketches with attached barcodes, an IR remote control and the gesturing SoapBox for navigation. With the PathCreator, we loaded three different maps on which to visualise the visits: an excerpt taken from the general map of the city centre, a topographic map of the area ordered from the city office and sketches created by the visiting participant with annotations of the lighting system. The feedback from the session was mixed. The media path recorded by the eDiary and calibrated on the map faithfully reproduced the visit and the position of the recorded media. The calibration of the path on the map was easy, thanks also to there being many points of reference (e.g. where the recording started, the form of the path, the sequence of places visited). However, according to the landscape designer, the 3DNavigator was not successful in providing a constant awareness of the position. The navigation was too close to the ground texture and, when moving into a more bird's-eye view, the red nodes (or filled circles in the figures) appeared too small. The map was distorted to show the altitudes of nodes, which would have been useful to appreciate the heights in the park. However, the recorded altitudes were not precise enough, as the accuracy is $\pm 15$ m. The physical control interfaces were successful in freeing the body from the PC, and they provided opportunities to access physical diagrams and sketches too.

### 4.2 A one-week trip around Austria

A more extensive trial was organised by providing two eDiary sets to a group of eight participants in a 5-day trip around Austria. This visit was part of a financed project for the nationwide farm cooperative to redesign the architecture of sites around Austria. The eDiary was used to organise thousands of pictures and sound files (3,400 files, 1.5 gb) using maps of parts of Austria.

Particular walking paths were also performed in some locations and recorded with the eDiary, which made it possible to revisit the path on a plan of the site, or with sketches. One eDiary set was used to record only the position of sites that could be visualised on a map of Austria (using the start and stop buttons, only a few nodes were created for each site; Fig. 11c). The second set was used to perform fine-grained paths on particular sites to be visualised on sketches or plans (Fig. 12). During the trip, the group used physical maps (with scale from 1:5,000,000 to 1:50,000) to annotate the positions of sites and made sketches of the typology and programming of sites (Fig. 11a, b). After the visits, the

**Fig. 10** Recording sound notes and taking pictures (*upper left*); the set-up for navigation (*right*)
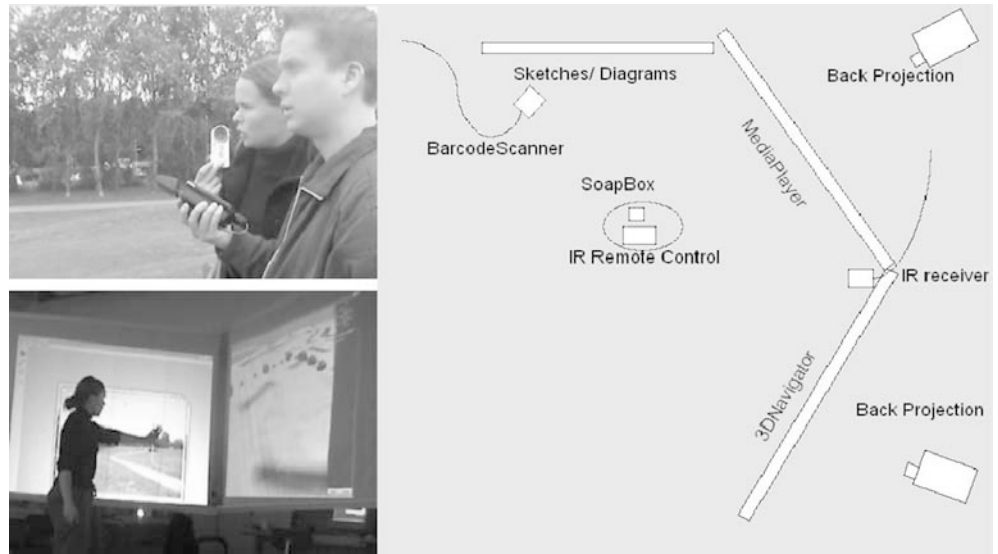
**Fig. 11 a** Maps used during the trips and annotated. **b** Sketches were made for each site. **c** Visualising the sites visited in one day
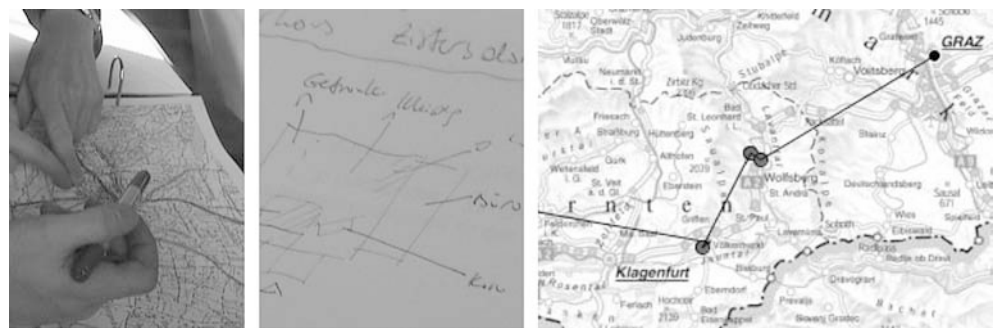
students navigated through the pictures and sound notes using the HTMLVisualiser. Pictures and sound notes were used to ground new concepts for the farm cooperative (e.g. with photomontages). Pictures, maps and sketches were also used to analyse the typologies of sites. Navigation of pictures and sounds was available for some sites by using detailed plans collected at the sites or on sketches (Fig. 12, left and upper right). In presenta-

tions, the students used barcodes on posters to retrieve pictures recorded during the visits (Fig. 12, lower right). We also organised two sessions to evaluate a set-up with two wall projections in the students' work environment and using physical interfaces.

This trial generated feedback on various matters. The supervisor of the group, an architect who had also tested an earlier version of the prototype, indicated the fact

**Fig. 12** A path around a building visualised on a detailed plan (*left*); another site from a sketch (*upper right*); during presentations, posters with barcodes used to retrieve pictures (*lower right*)
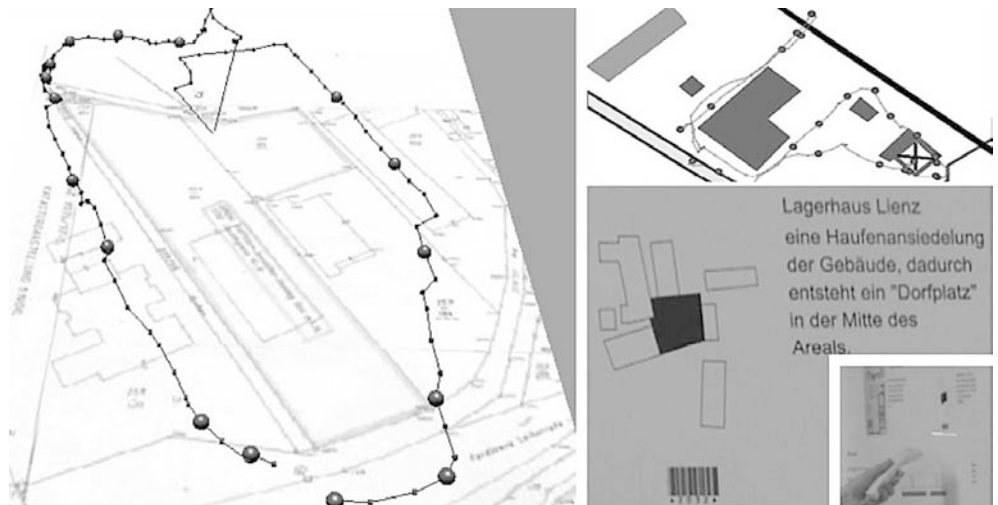
that visitors are able to perform a walking path and actions (taking pictures and sounds in particular positions) to create a multimedia path were attractive aspects of the concept . There are narrative elements that can be created, for example, the particular way taken by the users and sequences of actions that are recorded. After having used the eDiary and navigated the media path, the architect cited Michel de Certeau [13] with these words: "it's hard to be down when you're up." This explains the problem architects face in designing with a bird's-eye view on a plan, using models or drawings, "losing the particularity of the 1:1 life." According to the users, the prototype, in its simplicity, was able to combine the two views in a new way. For the students, it was useful to have a system to organise and share thousands of photographs, "keeping perspective of the experience of the place, of the flow, of how it is inhabited." However, students lamented that, during the trips, they used and produced other material that was not integrated in the system, such as annotations on maps and sketches. The creation of detailed paths was also problematic as the walking and the taking of pictures took place partially inside buildings where it was not possible to receive GPS coordinates. Also, while the "position of recorded media always has value, the idea of creating a walking path is not always interesting, and depends on the particular phase of the project." According to one student, "gesturing is better in navigating the paths than the infrared remote control. With the infrared remote control, I need to remember in which direction the infrared receiver is facing, in order to point it in the right direction." The advantage of gesturing was clearly more relevant in this case, as students present their work on various surfaces and tables around a room (posters, physical models, in one review session all the walls of a room are used). The 3D visualisation, even after the improvements introduced after the first test (more of a bird's-eye view increasing the size of the nodes), was hard to follow and made it hard to understand the current position. However, a student appreciated the intent of creating a more immersive and dynamic representation that also hinted at the possibility of using the 3D environment to load virtual models of buildings.

## 4.3 Sites in Vienna for public baths

Trials were also organised with a student within the context of her Masters thesis, which was about planning a site for public baths in Vienna. Among the many activities in her project, she analysed sites in Vienna that were related to water, such as fountains and open pools, and searched for a suitable site to plan public baths. She used the eDiary to visit several sites, sometimes alone and sometimes with another person operating the eDiary. One suggestion that she had after the first visits was implemented during the trial. She requested that it be made possible to visualise a group of paths as points on a map of Vienna. It was then possible to open a map of Vienna and to visualise all of the candidate sites that she had visited. By selecting one of the nodes, a more detailed map was opened, displaying a path. This requirement also emerged in the trial in the previous section, where the need to visualise the visits on two levels (the whole of Austria and the plan of the site) became evident. Several problems emerged in this trial. The digital camera and the eDiary were rarely synchronised and, for this reason, we implemented the feature in the PathCreator to re-synchronise the multimedia files and the GPS trace after the visit. The eDiary worked well in open spaces (parks and cooperative farm sites) and also inside cities, but not near buildings that were too high or which surrounded the site. In some cases, the visits were only partially recorded because of high buildings and the GPS traces were too imprecise. This also made the calibration of the maps very difficult. Recording several paths in one visit resulted in a lot of work in the sorting of files. As some visits were carried out by the student alone, this uncovered the difficulty of the same person taking pictures and operating the eDiary. In the words of the student: "I would like to put the thing (iPAQ) in my bag and walk around in the city, eventually taking it out of the bag to do some voice recording and taking pictures with the camera. After 1–2 h, I will go back to the Academy and put everything on the database. But I had to stop and start the program every 15 min." This happened as the iPAQ in the bag would lose reception or go on standby. The student had several suggestions for improvements. She suggested providing a GUI in the PathCreator to move the node locations simply with the mouse (it was possible to add nodes, but by writing the coordinates and not placing a node with the mouse). "I want to draw a path by walking there. But only as a first sketch. To use the representation later too, I need to be able to change the path and re-draw it easily." Moreover, not all the sites are visited, introducing the need to have ways to make similar representations for these sites too. The student also suggested a simple 2D map where the current node would change colour.

## 5 Discussion and conclusions

We have characterised visiting practices in a specific setting, architectural design at the Academy of Fine Arts, as being a process of experiencing places and collecting objects. Experiences and collected material are integrated and shared in the work environment in order to develop designs. The concept we set out to evaluate is to record and visualise multimedia files using traces of a walked path as an important element of the experience of the visit. We have evaluated a system architecture and a set of computational components indicating specific activities to be supported: visiting/recording, editing/storing, configuring/re-travelling. The last two trials provided situations that

demonstrate the value of the concept we propose: a 1-week visit to more than thirty sites of different typologies, visiting places in Vienna for inspiration and for a suitable building site. The multimedia and traces of walking paths could be combined to provide richer representations of a visit. The system architecture we proposed was complete in addressing the most important activities to be supported. Nonetheless, the trials uncovered serious limitations in the components. The eDiary introduces an additional device in the equipment for visitors and also needs a dedicated person for its operation. Moreover, the creation of multiple paths in one visit resulted in a sorting task. For these reasons, the eDiary would ideally be integrated into a multimedia-recording device, thus, solving the problems of synchronisation and sorting the media for different visits. Moreover, GPS technology, while providing a useful device for prototyping, is too limited to be able to support the recording of walking paths (no signals inside or near high buildings, imprecise, slow, etc.). The second activity, *editing*, has proven to be essential in order to integrate the media paths in the ongoing work after the visits. However, the PathCreator did not provide features for the easy manipulation of paths (e.g. moving nodes with the mouse). The support for configuration and navigation was successful in creating a mixed-media environment to share and re-travel visits, managing sound, pictures and position information. 3D navigation needs more sophistication if it is to be of more value than a 2D map. While the multimedia path is a successful and usable outcome of the process just after the visit, the walked path information tended to disappear (as projects proceeded), leaving only the recorded media in the foreground. In conclusion, the system architecture and components we proposed need to support transitions between work situations better. According to Büscher et al. [3], "people continuously configure and re-configure assemblies of materials, people, technologies and spaces" and transitions between these configurations are "inescapable" and need to be made seamless. To achieve this in our case, technological development needs, on one hand, to work for the coherence of the constellation of devices and components in the work environment. On the other hand, we need to provide better persistence and affordances for representations of walked paths to render this information more usable and integrated in the activities following a visit.

## References

1. EU IST project part of the Disappearing Computer Program, http://atelier.k3.mah.se/
2. Iacucci G, Wagner I (2003) Supporting collaboration ubiquitously: An augmented learning environment for architecture students, In: Proceedings of the 8th European conference of computer-supported cooperative work (ECSCW 2003), Helsinki, Finland, 14–18 September 2003
3. Büscher M, Kramp G, Krogh P (2003) In formation: Support for flexibility, mobility, collaboration, and coherence. Pers Ubiquit Comput 7:136–146
4. Davies N, Cheverst K, Mitchell K, Efrat K (2001) Using and determining location in a con-text-sensitive tour guide. IEEE Comput 34(8):35–41
5. Gaver B, Martin H (2000) Alternatives exploring information appliances through conceptual design proposals. ACM CHI 2000 2(1):209–216
6. Izadi S, Fraser M, Benford S, Flintham M, Greenhalgh C, Rodden T, Schnädelbach H (2002) Citywide: Supporting interactive digital experiences across physical space. Pers Ubiquit Comput 6(4):290–298
7. Pradhan S, Brignone C, Cui JH, McReynolds A, Smith TM (2001) Websigns: Hyperlinking physical locations to the web. IEEE Comput 34(8):42–48
8. Grinter RE, Aoki PM, Hurst A, Szymanski MH, Thornton JD, Woodruff A (2002) Revisiting the visit: Understanding how technology can shape the museum visit. In: Proceedings of the computer-supported cooperative work conference (CSCW 2002), New Orleans, 16–20 November 2002, pp 146–155
9. Randell C, Muller H (2000) The shopping jacket: Wearable computing for the consumer. In: Personal technologies, vol 4. Springer, Berlin Heidelberg New York, pp 241–244
10. Persson P, Espinoza F, Fagerberg P, Sandin A, Cöster R (2002) GeoNotes: A location-based information system for public spaces. In: Höök K, Benyon D, Munro A (eds) Designing information spaces: The social navigation approach. Springer, Berlin Heidelberg New York, pp 151–173
11. Tuulari E, Ylisaukko-oja A (2002) SoapBox: A platform for ubiquitous computing research and applications. In: Mattern F, Naghshineh M (eds) Lecture notes in computer Sc. 2414: Pervasive computing, Zürich, Springer, Berlin Heidelberg New York, 26–28 August 2002, pp 125–138
12. Kallio S, Kela J, Mäntyjärvi J (2003) Online gesture recognition system for mobile interaction. In: IEEE international conference on systems, man and cybernetics, vol 3, Washington, 5–8 October 2003, pp 2070–2076
13. Certeau M de (1988) Kunst des Handelns. Merve Verlag, Berlin