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Review

Of Catwalk Technologies and Boundary Creatures

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Researchers designing and deploying technologies in the wild can find it difficult to balance pure innovation with scalable solutions. We propose a catwalk technology metaphor where researchers as boundary creatures focus on innovation whilst providing links to prêt-a-porter (ready to wear) developments. Evidence from three 'in-the-wild' field-based learning case studies with 140 geosciences and history learners are used to conceptualise the researchers' 'boundary creature' role in managing these design process tensions, specifically for e-learning using mobile systems, distributed collaboration, sensors and augmented reality in quarries, up mountains and in the city. The analysis details the researcher issues of spatial/temporal acuity and socio-political astuteness in an adapted practitioner inquiry approach. Ultimately, a researcher design role (RDR) model reveals how researchers establish expectations with the design team, stakeholders and users around what is to be innovated (e.g. technology, activities) and how the system will change or enable current practices.

Categories & Subject Descriptors: H1.2 **[User/machine systems]** – *human factors*; H5.1 **[Multimedia Information Systems]** – *artificial, augmented and virtual realities; evaluation / methodology;* H.5.2 **[User interfaces]** – *evaluation / methodology, theory and methods*; H.5.3**[Group and Organisational Interfaces]** – *theory and models*

General Descriptors: Human Factors; Design; Theory, Methods and Models.

Keywords: researchers' role, boundary creatures, catwalk technology, innovation design, scalability.

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1. INTRODUCTION

As an HCI researcher working 'in the wild' we need to balance many conflicting needs. However, wild contexts such as field trip learning can also enable creative, often serendipitous, innovations that would never have occurred in a controlled environment [Rogers 2011]. In adapting design decisions to meet the complex changing needs of the wild, we can be free to be creative outside the constraints of the laboratory. What might be considered as innovative design decisions for technology enhanced learning up a mountain, in a quarry or on the streets of a city might be considered crazy in a classroom. As a HCI researcher working across different social, physical and technological boundaries we can easily be thought of as both bizarre yet also empowering. To enable the later perception we need to understand ourselves and the role we play in the research and design processes as we traverse these boundaries.

In the wild research can represent contexts that range from those that are physically desolate and uncultivated to those that are simply natural habitats for the users but not necessarily for the researchers. This makes the distinction between contexts that have physical attributes that are 'wild' and uncontrolled in contrast to contexts that can be perceived as 'wild' by those interacting with them. Our sense of control over a context could then be defined as one attribute of defining an 'in-the-wild' study. Within geoscience and historical field trips, presenting 'in-the-wild' learning is often perceived by both the learners and the researchers as a context that is 'in-the-wild' for them. However, often some stakeholders such as teachers and community organisations are in their

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comfort zones and natural habitats. This presents a very different situation from those usually encountered by HCI research in the laboratory where the researcher feels at home, but the user or stakeholders feel they are in unfamiliar territory. In all cases, the onus is on the HCI researcher to step across these boundaries to support the research and design processes.

It could be argued that these issues are important to any design processes regardless of whether they are in the wild or not. This paper maintains that these tensions become heightened and more valuable in wild projects. For example, whilst HCI researchers often seek to innovate in their research and designs, they also have to balance competing expectations from different stakeholder groups together with managing the practicalities of the design, development, deployment and evaluation process. Many within the educational field seek to turn those innovative designs into developments that are scalable and have sustained impact. However, the line between innovation and scalable, sustainable HCI design has become an ever more complicated one to tread. We propose that using a fashion design metaphor of catwalk technologies into prêt-a-porter (ready to wear) developments may be a useful one to consider. whilst the notion of researchers as boundary creatures might support managing those tensions. This paper reviews both these notions and strengthens them through theoretically underpinning them with a practitioner inquiry, cognitive ethnography and grounded theory perspectives.

2. BACKGROUND

The 'wild' context can act a crucible for inspiring serendipitous technical innovations [Rogers 2011]. However, along with the development of novel technologies for the wild, there is a push from stakeholders to develop usable, scalable and sustainable systems [Blevis 2007] making the tensions between innovation and scalability apparent. As part of this process, the researcher has to manage their role and identity within the design, development and deployment of systems with that of users in the wild. Within research-led education projects the approach towards innovation is overseen by the researcher, often within a complex social context. Within field work learning, dealing with this complexity often relies on the researchers' flexibility towards rapidly changing temporal, spatial and socio-political issues in the research process. In order to do this, the researcher ultimately relies on methods that support their own reflexive approach not only to the research within a complex changing context but also to the design process.

2.1 The Wild Crucible

Rogers [2011] discusses the role of technology 'in-the-wild' design as a move away from designing for user needs in-situ, to developing novel technologies for peoples' changing situated experiences. This highlights the issue of innovation in the design process as well as the reflexive nature of the researcher (i.e. not only reflecting on the design process taken but the methodology and epistemological approach taken and the researchers place in that process). Thus, this describes a shift in HCI research from a task driven approach to one that focuses on experiences, creative and often serendipitous inquiries There are many issues that impact on the 'wild' design process described here; from designing for an embodied [Beckett and Morris 2001; Giddens 1984] or felt experience [McCarthy and Wright 2004; Wright et al. 2008] to that of the cognitive sense making process [Hutchins 1995]. Rogers [2011] argues that the next challenge is a need to create new 'wild' theories. The wild theories we focus on specifically in this paper examine the researcher role in designing novel technologies for field trip learning and the need for balancing issues of innovation against the pressures for scalable and sustainable solutions. The generalisation of this work is achieved through reference to research in other 'wild' domains that have encountered similar issues. This paper therefore seeks to inform the design of broader 'in-the-wild' human systems [Becvar et al. 2008; Hutchins 1995]. The researcher has one of the most important roles in this process.

2.2 The Researcher as Boundary Creature

Johnson et al [2012] review some roles that researchers take on within an 'in-the-wild' study and some insights provided by the investigator in the evaluation process. This paper details within a well-defined wild context and the complex researcher role when becoming a participant observer (as perceived by themselves and the participant). The roles are described as those of facilitating or encouraging, explaining, developing a level of authority, a familiarity with participants, and a relationship with their research. The reflexive approach to this research has unpicked personal accounts of the researchers' evolving identity within the research context and how they facilitate the technology users' development of identity. The social-psychological role of the researcher in the research process has long been debated [Atkinson and Hammersley 1994; Henwood and

Pidgeon 1992; Willig 2001]. However, their developing identities when researching the design process are sorely under-represented.

The literature on identity theories has been developing for centuries but we focus upon identity in technology enhanced situated learning contexts. "Who we are", is very tightly interwoven with "what we have learnt" [Bernstein and Solomon 1999]. However, our identities are not fixed commodities that can be simply traded up or down after learning occurs. We remain one person who inhabits multiple social worlds [Goffman 1969; Lave and Wenger 1991]. Our identities are a muddled interaction of perspectives within those changing social worlds. Added to this chaos is the impact from each situated space and time in the learning process [Bowker and Star 2000]. Physical, temporal and social psychological contexts can seriously impact on our identities and their development. Moving between different locations has been thought by some as physically separating these identities. 'I'm at university now so I'm a student, I'm at work now so I'm an employee, I'm home now so I'm a daughter / son / mother / father'. However, our identities, lives and the learning process cannot be as clearly divided as this, with most of us living in blurred overlaps. However, it has been argued that the gap between our identities in different social worlds should never be fully bridged otherwise how can we be encouraged to continually develop and transcend our immediate practices and identities [Guile 2006]? Learning often involves dissonance and disequilibrium not only for our own identities but also for others, as identity reconstruction can impact dramatically on organisational and sociocultural objectives [Alvesson and Willmott 2002].

For centuries the teacher has taken on the role of supporting not only our learning processes but our identity reformation. Technology on its own cannot and would not replace this role. However, technology can facilitate the learning process, albeit with inevitable gaps due to poor or inappropriate design of these systems. As we have noted, social practices shape how we learn and, in turn, who we become [Lave and Wenger 1991]. However, although knowledge may have its roots within a formal discipline area (e.g. history, biology, mathematics) this paper reviews a broader perception of what 'knowledge' is. Knowledge can be enclosed by both formal and informal practices which are not fixed as we produce schema and mental models which are cognitively, contextually and socially mediated. Technology as 'boundary objects' often traverse these knowledge domains and social structures, and support communication and collaboration by acting as an interface between these boundaries of domain knowledge [Star and Griesemer 1989]. These boundary objects can be thought of as both enablers and barriers to understanding. Some objects facilitate knowledge sharing and understanding across boundaries. Other boundary objects become barriers for users moving between communities as they may be embedded in local jargon, informal practices and unfamiliar norms of behaviour. As HCI researchers and designers we often aim to design boundary objects that allow users to flexibly move between communities and contexts expanding their knowledge as they go. However, our use of these objects and their smooth movement between communities is often hampered by poor design. For example, Adams et al. [2005] present evidence of how the poor design of digital libraries for use across healthcare settings, where different terminology is used and practices are the norm, produces poor access to safety critical information.

The role of intermediaries supporting technology as an aid to the learning process was evaluated by Murphy and Adams [2005]. Their research identified great benefits in the support but found that these were qualitatively larger indirect benefits (such as changing roles and responsibilities, improved social interaction) rather than direct benefits (such as cost and time saving, skills acquired). In a related study, Adams et al. [2005] specifically review the use of digital library technology within the healthcare setting as a lifelong learning resource. They identify how an information intermediary (e.g. a librarian) can compensate for the inevitable gaps between system design and users' ability, awareness and motivation. Ultimately the research identifies that the information intermediary can act as a flexible catalyst for producing and empowering technology within the community of practice. The paper concludes that it is important to further understand the relationship of communities within social structures in order to ensure that technology can facilitate (and not inhibit) learning in those groupings. We argue that these intermediaries act as 'boundary creatures' moving between different communities of practice, in keeping with McGinnis's definition [1999] of the intermediary role as being 'a boundary creature [that] inhabits more than one world' (p.61).

Donna Haraway [1991], the feminist scholar and historian of science and technology, presents a more complex notion of a 'boundary creature' as a deviant from the norm and a 'monster' (resulting from the Latin origins of 'demonstratus' – to demonstrate and 'monstrare' – to show, derived from 'monstrum': a sign or portent). Burt [2005] in contrast highlights how brokers

For Peer Review

between social worlds can gain social capital as they appear creative, insightful and possessing a genius born out of the import-export of ideas. As HCI researchers in an educational research led processes we move and import concepts between different social worlds thus requiring a certain degree of temporal and spatial acuity. Understanding when, where and from whom information is important enables us to bridge 'gaps' between different communities. As well as temporal and spatial acuity, we also require political astuteness which often requires an understanding of the 'passion' that many of these concepts evoke in people. Jones et al. [2004] discusses the notion of bringing passions back into the study of social structures to remove the idea of knowledge being thought of as an 'objective representation' or a 'social construction'. It is argued that the issue of alignment with notions of 'good' and 'bad' practices and outcomes need to be reviewed. Many organizational initiatives and teaching practices have a history of evoking emotive responses as the balance between creativity and standardization are maintained [Bernstein and Solomon 1999]. It could similarly be argued that we need to provide flexible support to affective responses to the balance between the creativity of technical innovation and the call for standardization leading to practical, scalable, sustainable, mainstreamed systems. Within HCI, this has long been a tension that different design processes have sought to deal with. Although this paper is not a detailed review of those design processes for the wild, we do examine tensions in that process that the researcher has to balance.

2.3 Innovation and scalability in the catwalk technologies design process

Innovation could be defined as simply a novel change without any association to improvement. However, as HCI researchers we seek to associate any innovation with benefits for the users. One approach to innovation that links with enhancement is that of transformational design. But how should we make those transformations? Within computing, transformations often refer to the computational transfer (e.g. of data, packets etc) from one node to another. However, in the design and learning domains, transformation refers to transforming the self. In the design community a transformational design perspective [Burns et al. 2006; Design Council 2011] looks at technology design as taking the viewpoint of and making things visible to the self often through prototyping as a key step in this process. However, within the design lifecycle for transformational design there has been an undue emphasis on the adoption lifecycle and so naturally this approach focuses on metrics for scalability and sustainable systems.

Adams et al [2005] highlight the importance of viewing the design process as evolutionary or revolutionary. Their research, on the design of digital libraries in healthcare settings, defines these two processes as:

- Evolutionary design involving incremental design changes, responsive to recognised needs whilst maintaining consistency in the fundamental design concepts.
- Revolutionary design involving conceptually new designs with new possibilities that create exiting changes which may not be acceptable and thus sink into oblivion.

They argued that technology progress consists of a well balanced mix of these two design approaches. In particular, this paper focuses on the role of the 'information intermediary' within the organisation of study (i.e. hospitals) as a catalyst to support design processes that maintain evolutions of redesign whilst allowing for revolutionary design through engagement with communities of practice. They also add that a combination of social and organisational forces and pressures (both internal and external to the context of study) can create revolutionary ways in which people work and use technology. One thread, however, that this research misses is that of the researchers' role in the design process.

Within the HCI domain, research into online communities has taken many approaches to learning theory in order to gain a different lens on designing systems for participation in online communities [Bryant et al. 2005; Preece and Schneiderman 2009]. Bryant [2005] in particular emphasised how the design of novel cooperative systems can produce a 'transformed' use of tools, views of the community and ultimately the users' identity. Much of the literature on technology and embodiment also draws from a literature around learning, identity and the self. Schiphorst [2011] reviews the design process for somatic experiences from four different perspectives of the world: a Cartesian view; first person; second person; and finally viewing the world through a mirror of the self. It is argued that self-learning and self-knowledge occur through co-experience of these perspectives, which can then, in turn, transform the self.

Within the fashion world the designer is considered visionary. Ferrero-Regis [2010] presents the concept of catwalk fashions as being considered more as wearable art or fantasy garments rather than being aimed at the prêt-à-porter (ready to wear) market. It is argued that previous catwalk fashions taken into department lines were scorned as copies of the original, even

For Peer Review

producing copyright battles. They argue that more recently the catwalk fashions have acted more as creative inspiration for the fashion houses with a push for an adapted design process being accepted throughout the industry. Within HCI a similar tension between the creative and practical has being growing. Wolf et al. [2006] give a detailed account of the tensions that have been growing for decades in HCI between an engineering design approach and a more qualitative and creative design-oriented approach. This paper argues that both approaches are not mutually exclusive and are both valid.

If we take this approach into wild technologies, we can see a theory for a '*catwalk technologies'* approach to design processes whereby innovation leads the development process but provides hooks into an iterative scalable and sustained technology design process. Wolf et al. [2006] detail the elements of a creative design praxis as those of a non-linear process; design judgement (i.e. knowledge, reflection, practice and action), creating and critiquing artefacts. Their paper argues for respect for the creative design process and an argument presented around how creativity in design and iterative engineering design are both essential in the design process but are not necessarily combined in one activity. This seems to concur with Rogers' [2011] arguments around novel wild technologies.

2.4 Field-based technology and learning innovations

Field trips form an important part of learning in many domains providing a valuable experience beyond the classroom. However, field work is inherently complex and students can become overwhelmed by its complexity unless the value of the experience is carefully explored [Boyle et al. 2003; Spicer and Stratford 2001]. But how do we define a valuable experience? For the purposes of this paper we focus on learning where there is a clear pedagogical benefit to either a formal or informal learning process. One way to review this is through the level of critical reflection within the experience. Reflection-in-action as defined by Schön [1983] happens in what is the 'action-present'. This is highly appropriate for wild research, since it comes in response to a surprise experience felt by the learner where the expected outcome is beyond their 'knowing-in-action'. This reflection-in-action process focuses on challenging the learners' assumptions, allowing them to think in a new way about the problem encountered. Schön [1983] argues this is very different to the 'reflection-on-action' that is often designed for in traditional learning activities. Within traditional field-based educational activities, the learner often collects data in the field and then reflects upon it in the laboratory. Taking a 'reflection-in-action' approach the students should be reflecting on learning whilst 'in-the-wild'. This is not to say that the learner will not reflect again 'on-the-action' at a later date but the focus in this paper is on their learning experience in the wild, in the 'action-present'. The technology should therefore support this reflection process whilst 'in-the-wild'. The importance of guiding these reflections so that they are substantive enough to be of value yet constructive enough for developing others reflective learning has been noted by several researchers [e.g. Land 2004; O'Malley and Scanlon 1990].].

When reviewing technology in the wild there are several hierarchical and ontological models that review concept of ecologies with regard to resources and devices [Luckin 2008; Nardi and O'Day 1999]. Many recent reviews of learning within a field context also review the importance of social and political structures with regard to these resources. Adams et al. [2005] highlighted the impact of social and hierarchical impacts on the use of resources within hospital settings. As these socio-political issues impact on the implementation of technologies in the wild then, previously noted, researchers require astuteness in their reflexive account of these issues. However, whether we are focusing on the resources or the devices, all these theories highlight the importance of the contextual experience.

'In-the-wild' research has uncovered several directions of value to the reflective learning process [Sharples 2000]. The concept of time and space in collaboration is one that researchers into experience design have started to unpick; for example, Marshall et al. [2011] view the concepts of using technology within space in the wild as distinctly different to that of the laboratory. Schiphorst [2011] relates transformations of the self and our own state to the physicality of the somatic (corporeal) self rather than the visceral (perceptual) experience. This could also be related to the physical experience within a field-based learning situation in a storm up a mountain, on a sunny day in a quarry or in the rain in the city.

Nerb et al. [2007] highlight how time factors increase the importance of ordering complex tasks, to increase the learning potential from an interaction. Benford et al. [2009] reviewed the interaction between different spaces, and the concept of moving between real world and virtual spaces. The interaction trajectories conceptual framework developed from this research provides a useful starting point for exploring concepts of collaborative learning and technically mediated

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experience design. The framework identifies four key concepts; *space*, *time*, *roles* and *interfaces*. Their continually changing inter-relationship with each other through temporal factors is a very relevant concept when considering 'in-the-wild' research.

2.5 The research process and the researchers role

At the heart of this review are some issues that relate to the researchers' identity in the research process. However, related to this are complex inter-relationships of identity change and reformation throughout that research process. A student taking part in a learning process, whether as part of a research project or not, undergoes an evolution in changing their perceptions of their own identity. The researchers conducting the research also develop their own identity and together they advance the identity of the research itself. This can be defined along the lines of physical, temporal and social psychological contexts [Adams In press]. Although complex, this process of identity reformation can benefit from our understanding of the technology as facilitating or inhibiting these transformations. One lens that can help us understand this process is that of social and contextual boundaries that we and the technology cross over. Thus it can be extremely beneficial to be reflexive with regard to this process. Reflexivity (i.e. taking account of the researcher within the research process) has long been considered by social scientists as an important part of the research process [Atkinson and Hammersley 1994; Henwood and Pidgeon 1992]. Henwood and Pidgeon [1992], when reviewing grounded theory, suggest that all good quality research should provide documentation of the analytic process and a reflexive account of researchers' research backgrounds and perspectives. With regard to HCI, Adams et al. [2008] detail the importance of reflexivity in a qualitative HCI approach. Reflexivity, whilst being a central element of phenomenography, is also considered an important part of two other research methods relevant for wild research and in particular field based learning: cognitive ethnography and practitioner inquiry.

Cognitive ethnography is suggested as an alternative approach to traditional ethnography which reviews the meaning that participants create within a situation by examining 'how' that meaning is made [Becvar et al. 2008; Williams 2006]. It is suggested that the researcher brings to the study several forms of pertinent expertise around: 1) knowledge of the activity; 2) knowledge of the discipline being observed;3) theoretical and methodological underpinning; and 4) knowledge of the community of practice being studied. We would also add to this, that through the research process additional expertise is developed in the form of an increased understanding of the context; with regard to the case studies presented in this paper, this is specifically around the *situated* learning context (e.g. the physicality of a particular mountain and its interpretation within different conditions and through different technologies).

The concepts of practice and the practitioner in the research process are central to the methodological approaches underpinning practitioner inquiry. Practitioner inquiry is an extension of action research which has been used effectively within practice based contexts for several decades [Carr and Kemmis 1986; Drennon 2002]. This approach to research supports the development of knowledge contextualised within specific contexts of practice and particularly emphasises the role of collaboration. Practitioner inquiry also highlights the importance of a cyclic self-reflective systematic inquiry; to plan, act observe and reflect (see Figure 1).

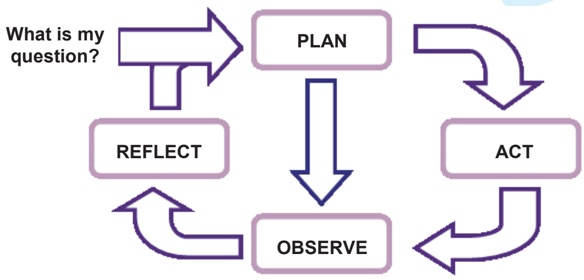

Fig. 1. Practitioner inquiry cycle [based on Reason and Brandbury 2001]

3. RESEARCH METHOD

This set of 3 studies covered a range of different technologies for geoscience and history e-learning, for a variety of different types of users. This was based within formal and informal learning in Higher Education and for the general public. The 'in-the-wild' contexts ranged from mountains and quarries, to cemeteries and lastly the streets of a city. The research design processes

For Peer Review

ranged from a 6 month to a 14 year period, and results from users – university students, school children and the public – were gathered, compared and contrasted, to identify issues relevant to the role of the researcher in the design process, both specific to each study and generic. Current work practices were identified and the impact of the design process on those practices was assessed. A pre-defined concept of an 'in-the-wild' design process was not employed, so that users could explore what they perceived as comprising these systems.

3.1 Study 1: Out There In Here

The 'Out There and In Here' (OTIH) project examined the possibilities for new technologies to support distributed, synchronous collaborations between students in the field, and others based in a stationary location (an indoor lab). The design process involved a 1st stage workshop, gathering perceptions from 19 earth science and postgraduate students around the nature, requirements and benefits of field-based learning. This was followed by the core researchers working with an interaction designer (external to the organisation) supporting a creative and focused design process. Once a system design had been established, the interaction designer supported developing graphics for the system. Once prototypes had been developed, participants took part in a technology pilot on a nature trail nearby. The system was then adapted according to feedback from the participants and the research team. Once the full system was developed, 21 students participated in a geosciences field trip using the OTIH technologies. The lab had projections onto three screens of the 'Out There' camera feed, an interactive table display and data presented on a laptop. A table was set up for the 'In Here' team control desk, with another table for hardcopy materials such as books, leaflets and British Geological Society maps to which the team referred during the course of the live trials. The interactive multitouch tabletop was set up for mapping and enlarging artefacts discovered Out There and prompted further field investigation. Researchers from the project team, housed in an adjacent observation lab, were able to look through the one-way observation window to monitor lab activity. In addition, two wall mounted-plasma screens in the observation room showed what was being projected in the lab.

The student team Out There at the field site (a local quarry) used mobile phones with Internet access to communicate with the student and tutor team in the lab. They sent geotagged photographs taken on location via their smartphones to be mapped on the interactive table in the lab. The In Here team used this and other information communicated during the field work to build an overall picture of the dig, gave feedback and their observations to the team Out There and even provided links to relevant websites and scanned pages from books to help inform further enquiries. Various hypotheses were formulated during the trial, and students were able to vote on whether they agreed with these or not.

The students were given a short questionnaire before the trial and at the end to establish approaches to hypothesis generation. They were all filmed in both locations throughout the trials. At the end of the trial a focus group discussion was completed with each of the teams. Afterwards, the whole group was brought together to discuss the day's activities. Finally, the research team met after the trials for a debrief session on the activities and how to develop the system further. The tabletop and mobile systems were redesigned over several subsequent trials to support a wider group of participants and activities.

3.2 Study 2: Mobile GIS

The title Mobile GIS (Geographic Information System) is used to describe a range of practical fieldwork activities carried out by students from the School of Geography at the University of Nottingham, dating back to 1997 but with more recent technological advances occurring from 2007-2012. Each year, a different cohort of students attended a short residential field trip to the around March/April, to investigate how information about the landscape could be visualised and represented through mobile media. Over this fifteen-year time period, more than 100 students attended these field trips, initially presented as an option as part of a wider field trip for first-year undergraduates (1997-2007) and later as a standalone module into the use of mobile GIS in the field (2008-2012) aimed at third-year undergraduates.

The learning outcomes on these field trips focused specifically on the application of different techniques and digital geographic data in the field, to present information and visualisations about the local environment and also to consider designs for future in-field augmentation.. Students were asked to conduct HCI evaluations of the usability and suitability of a range of approaches that included:

- acetates: these were printed acetate sheets featuring perspective outlines of the terrain rendered from particular viewpoints in the landscape by students using Digital Terrain Modelling

For Peer Review

software overlaid with labels or other annotations and used by participants when in the relevant physical location (see Figure 4). The use of acetates was originally used as part of a field exercise to encourage students to compare digital models of landscapes with the real world scenes, to raise awareness of the representational fidelity of such models;

- 'electronic acetates', using GeoMole, an application on a PDA (Personal Digital Assistant). GeoMole was a digital equivalent of the acetate exercise albeit relying on loose matching of the scene rather than through direct transparency overlays. This was developed in part to explore some research questions related to in-field geographic visualisation, but also to add additional capability and flexibility to the teaching exercise (e.g. it enabled sketching of notes on the PDA and avoided the bottleneck of printing many acetates in a short time frame);
- Google Earth running on a tablet computer: this provided layered geographical and geological information, through a larger screen, a familiar interactive interface and the ability to switch from first person location-centred view to aerial perspective;
- mScape (MediaScape) software [Stenton et al. 2007] delivered on a PDA: this enabled students to investigate the geographical relevance of locative media, triggered by the participants' movements through various 'trigger regions', by allowing students to author their own content and associate this with trigger zones of various shapes, sizes and positions;
- Geo-located Virtual Reality delivered through a head-mounted display and laptop [Jarvis et al. 2008]: a VR headset showed computer generated reconstructions of valley glaciers, as a way to visualise the size of position of such features from a first-person real-time perspective in the field (see Figure 3);
- Layar (an AR - Augmented Reality application) on a smartphone: This allowed students to explore real-time augmentation and electronic annotation of the landscape, using a digital compass in addition to GPS (Global Positioning System) position;
- Zapp [Meek et al. 2012]: another simple AR app, that allows authoring of zones on the landscape to be overlain with digital information. Rather than using a typical, 'where's my nearest query of trigger zone, it uses a line-of-sight algorithm along with a digital terrain model to allow users to point the device at a distant part of the landscape and derive information about that area.

Students on the field trip were asked to record video diaries as part of the experience, and it is through analysis of these diaries, together with researcher observations and follow-up focus groups, that we have obtained critical reflections in respect of practitioner inquiry and the broader findings presented in this paper.

3.3 Study 3. Hidden Histories

This project investigated the use of location-based audio to enable public learning of historical events, specifically the 1831 Reform Riot as it occurred in the city of Nottingham, England. The audio was delivered through two different types of walk: a guided, 'person-led' walk with historical information narrated by members of a community history group at specific points of interest along a planned route; and another, 'technology-led' walk, where the audio narrations were delivered through location-aware smartphones at the same points of interest as the first walk. Both experiences were carried out in groups, although the person-led walk was attended by approximately 50 participants whilst the technology-led walk was tested out by a much smaller group of 6 participants.

Many of the participants for the person-led walk already had contact with the community history group, being existing friends or acquaintances. Those attending the technology-led walk were recruited directly by the research team, through existing acquaintances known to have an interest in local history, but not directly associated with or known by the community history group.

The community history group had planned to carry out a guided walk around the streets of Nottingham but this in itself was a new activity for them and they had not thought to attempt to use any form of technological solution to help them in this endeavour, beyond the use of their group's website to publicise the event and upload historical content (or links to such) that were of relevance to the walk and the Reform Riot itself. They had planned the walk to take place with people as the central resource, who would guide the participants around and stop them at relevant points of interest; they then took it in turns to read out pre-prepared narrative, based on a variety of historical sources. Very few of the community history group owned or were experienced in using smartphones and the idea of using a device that utilised GPS)as means of detecting location was considered (by them) to be beyond their capabilities, in terms of technical 'know-how'.

Data from participants were collected through questionnaires, researcher observations (where possible) and group interviews. In the person-led walk, the research team were able to take on the role of participant observer, although in the technology-led walk the researchers were not able to take on this role, as their attention was mostly taken up with resolving unforeseen technical issues with the equipment and guiding the participants from one point of interest to another.

3.4 Data collection and analysis

This paper takes an approach to the research which merges cognitive ethnography, grounded theory and practitioner inquiry. Practitioner inquiry provides an overarching theoretical perspective on the evaluation process appropriate for technology enhanced situated learning. Cognitive ethnography [Becvar et al. 2008; Williams 2006] provides guidance on knowledge bases to be utilised and data to be collected and finally grounded theory [Adams et al. 2008] can provide an analysis approach that ties these three together.

More specifically the approach taken to these case studies by the research teams has been according to an iterative practitioner inquiry cycle (i.e. plan, act, observe, reflect OR observe, reflect, plan, act, observe, reflect), collecting data to identify systems and procedures that can enhance teaching and learning processes. The research teams have utilised their knowledge to guide data collection around 5 themes:

- Knowledge of field-based inquiries,
- Spatial and historical knowledge bases specific to the humanities,
- HCI and teaching and learning theory bases
- Understanding the specific communities of practice for the stakeholder groups involved in the design processes.
- Specific technological device benefits (e.g. augmented reality, mobile devices, distributed communication systems).

From a cognitive ecological perspective we need to understand the full complex interconnections (including culture, context, history and affect) that impact on cognition which is especially important for learning. This theoretical approach strongly ties up with cognitive ethnography, and thus strongly highlights identifying correlations between multiple reflections of all parties within the field-based learning system design process. Therefore, rather than taking an auto-ethnographic approach [Cunningham and Jones 2005; Cunningham et al. 2010] focusing just on reflexive accounts from researchers, this study uses a network of reflections impacting on the researcher and the research (i.e. users, stakeholders, designers and developers) to understand the researchers' role within this wild research. The data collected within each of the studies was similar in its qualitative roots (i.e. reflections from researchers during and after the design process, video recordings of the project evaluations, participant questionnaires and in-depth interviews and focus groups), although it differed in the depth and variety of data collected as the projects ranged in length from 6mths to 5yrs. An in-depth analysis of all the data was conducted using a grounded theory approach [Strauss and Corbin 1990] with the data collection and analysis combining systematic levels of abstraction into a model, which was verified and expanded throughout each study and into a final meta-analysis across the three case-studies. This meta-analysis was examined through a standard grounded theory format (i.e. open, axial and selective coding and identification of process effects). Once analysed, the data synthesis was verified with the case study project leads to verify its validity.

In the results discussed below, many points are illustrated with verbatim extracts from the interviews, focus groups and video extracts. In these quotations, the speaker is identified by the study, and given a participant number to distinguish their accounts from other participants (so, for instance, HH stands for the Hidden Histories project and p6 as participant 6 in that study; OT stands for 'Out There' field based student, whilst 'IH' is the 'In Here' lab-based student).

4. RESULTS

Throughout the analysis of the data from the three studies there was a common theme on the need for the researcher to balance tensions around three important issues for field trip learning technology: spatial acuity, temporal acuity and socio-political astuteness.

With regard to issues of spatial acuity, the researcher must understand that the field trip technology could supplement outdoor spaces by increasing the amount of relevant information available, resulting in critical reflection, immersion and emotional engagement by visitors. However, the risk is that poor design of the technology can distract from those spaces, in some cases making them more dangerous.

Within field situations, time was found to flow in a different way to that in the laboratory where many devices are designed and developed. For researchers, effectively balancing this temporal difference can produce an increased reflection in the field which is beneficial for learning.

For Peer Review

However, researchers taking too much control, through orchestrating time in the field, can disrupt the natural flow of activities, making them too time consuming, slow and inflexible for changing user needs.

Finally, the project researchers felt the pressure of socio-political issues and their own astuteness, with regard to these needs, allowed for more effective technology enhanced field learning. The researcher needs to consider obvious social issues such as shared rather than personal devices for group work. However, some social context issues may not be so apparent whilst still impacting powerfully on the learning process through a sense of increased inhibition (i.e. looking silly in public) or decreased safety (i.e. feeling at risk in public). The political issues can be a lot more subtle but still require the researcher to remain aware of related impacts on the design process. Stakeholders' desire for scalable and sustainable systems can push developments in specific directions, whilst some collaborations with groups may allow the expression of ideologies offensive or inappropriate to the users, that may appear to be championed by the technology.

4.1 Spatial Acuity

The HCI researchers' sensitivity to spatial issues is particularly important to studies 'in-the-wild' since the physicality of the environment is of paramount importance. The use of the technology can change within different 'wild' environments and the researcher has to adapt designs, activities and evaluation procedures to fit with these environmental changes for example: "It was raining so I had to put [the device] in a plastic bag." (HH p1)

4.1.1 Spatial technology design

Within all the projects the technology provided increased access to information that was tailored for the participants' location and learning needs. The 'Out There In Here'(OTIH) project sought to achieve this innovation in geology field work by using an ecology of multiple devices distributed in 'live' communication between the field and a laboratory. However, whilst the technical innovations in the laboratory were fairly easy for the researcher to maintain, in the wild there were a number of technological challenges. Of key importance was the issue of technology in relation to the weather. The research team had to deal with severe delays to the project because the laptop suppliers had, from their own volition, upgraded the technical specification for the laptops to those with touchscreens which could not be viewed outdoors. In contrast the tablet computers (e.g. iPads) that the research team used could be viewed easily on cloudy days during initial piloting and trials; however, during the height of summer, participants could only see the tablet screens effectively by covering them with umbrellas or coats (see Figure 2).

Fig. 2. Using iPads 'in-the-wild', illustrating use under different environmental conditions

Researchers in the Mobile GIS project found some environmental problems were exacerbated when walking in a mountainous area for their field work:

> "I thought with the hand-held [devices] they were good, you know, because they were so mobile and stuff. But I thought when you're up on the mountains there's often like wind and rain and glare and things, so if you're trying to look at a screen often like there's going to be like sunlight reflecting off it or the wind, you can't hear it because the wind's going to be gales." (MGIS p12)

When seeking to innovate in the wild, one spatial issue that must be considered by the researcher is the users' management of these pieces of technology. The Mobile GIS project required the students to compare a multitude of mobile devices, one of which was a mobile virtual reality (VR) headset, connected to a laptop that was carried in a backpack. The geography students described this technology as cumbersome and heavy:

"I don't want to carry so much electronic devices with me … the augmented reality kit… was very heavy, a very big device on [your] back with the computer in it." (MGIS p5)

The research team developing the technology in the laboratory had endeavoured to make the system as light as possible, although the wild context did intensify issues already identified. The use of a VR system in the laboratory was noted by the researchers as increasing the sense of immersion in the virtual environment, which could be physically moved through in the real world. This was noted as a safety issues by the researchers when the students were up a mountain, as students could not see the real world through the VR headset and so couldn't see where they were going (and thus be unaware of dangers in the environment such as uneven ground or even a cliff edge), thus the participants were asked not to move around whilst wearing the headset outdoors. However, so powerful was the immersion in the system that the researchers found it hard to stop the students from involuntary movements with the headset on. Students' video diaries show quite powerful shots of students moving towards cliff faces as they move through VR shots of the landscape with researchers or fellow students stopping them before this becomes dangerous.

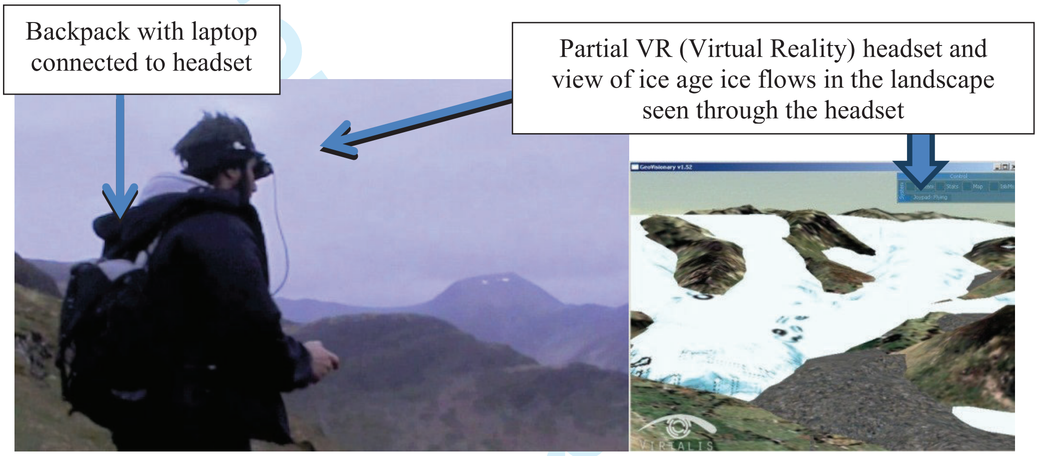

Fig. 3. Geo-located Virtual Reality, showing user and user's view through the headset

In contrast, although the smartphones in the Hidden Histories project were small and carried easily, participants still had to manage this new technology with the everyday objects they required on a daily basis when in the wild of the city:

"I had to keep taking off my gloves and juggle the umbrella/paperwork to switch the phone on and off." (HH p1)

4.1.2 Spatial activity design

All the projects reviewed sought in different ways to innovate field trip activities to enhance learning outcomes. The OTIH project sought to design an innovative learning activity in conjunction with the technology design. Traditional field trips require students to interact with the environment and reflect on their learning either within that situation or at a later time. This project sought to change that approach by using technology-supported distributed collaboration to support 'live' group reflection in both the field and the lab, during the field trip:

"and you heard what was being said by the people in here and you thought, Ah, nice little point, nice bit of direction and let's go and have a look at that particular aspect." (2OT p1)

However this innovation to the learning activity did produce spatial implications that had not been fully understood by the research team before starting the evaluation trials. For example, the students in the laboratory found it difficult to spatially locate and understand the information they had received from students in the field. This was noted as a potential issue by the team in the design phase and was thought to be counteracted by geo-referencing the data from the field location, so that those out of context in the laboratory could locate it on the map and build a

For Peer Review

coherent picture for themselves. Unfortunately, the limited accuracy and scope of the GPS geo-tagging was not sufficient for the scale required with the geological tasks. This made it hard for the team, for example, to locate whether one fossil was found above another and thus hypothesise about landscape changes across the different era. However, the multiple different communication technologies provided for the students (e.g. phone, SMS, live video feed) allowed them to communicate these issues and again encouraged those in the wild to reflect on their own activities.

"sometimes the field trips I'd been on, you just go and look at the strata [layers of rock] and then you're discussing or drawing something, looking at grain size, sorting things like that, whereas this time I felt you looked at the whole picture." (1OT p6)

For the Mobile GIS project, innovation of the spatial elements in the learning experience was crucial. The research team engaged in reflective practices, resulting in several developmental iterations from the low technology use of computer-generated acetates, to mobile representations of geospatial data and head-mounted displays. Throughout each innovation there was a core set of spatial learning criteria focusing on critical reflection of the landscape through examination of reconstructed viewpoints compared to the current landscape. The students noted how powerful the innovative spatial approach was, regardless of the technology used:

"the acetate was actually so effective, because you could, it was very easy to sort of place yourself in the right position and then it's just there in front of you" (MGIS p14)

Fig. 4. Examples of how the acetates were used in the field

The transparent nature of the acetate which emphasises the visual richness of the landscape and simplifies the additional layer, meant that students easily related the two together. Within subsequent technical advancements in the visualisations, the richness of additional layers meant that students were absorbed with the electronic media rather than the real 'wild' environment. For example, students were observed noticing only general aspects of their location and thus incorrectly identified one particular location as the target valley (the actual target location being behind them). Recent developments using the Layar augmented reality application, as a 'digital acetate', have sought to retain the simplicity of these acetates whilst allowing a more rich and varied content to be accessed.

Within the Hidden Histories project, participants' interaction with the information was designed to be related to a specific physical location. The project aimed to allow the general public to interpret for themselves conflicting accounts of the same historical event tied to certain key locations, in order to allow them to critically reflect and produce their own understanding of the event as and where it happened. To support this process, the system had information from historical sources linked to specific locations and provided through GPS-enabled devices, which would only activate once participants entered each 'trigger region'. This approach to the learning activity meant that the user did not have to interpret what location they were at, in order to trigger the appropriate audio information (which might otherwise lead to participants' accidentally hearing information in the wrong context). This left them free to visually and physically experience the space they were in, whilst listening to the appropriate dialogue. The researchers noted how, with many of the participants, this increased their emotive response to the accounts and their memory of details given, as they could concentrate on the audio narrative rather than having to work out if they were in the right location. However, researchers found when using the

For Peer Review

technology in the city streets that 'not spots', i.e. areas of unreliable GPS and/or WiFi connectivity [see Gaved et al. 2010], rather than 'hot spots' increased the frustration for the participants:

> "A couple of the stories didn't kick in. Finding the exact location for the stories to kick in was rather difficult." (HH p2), "The GPS didn't work, so I had the manual instructions." (HH p6)

4.1.3 Summary

Ultimately technology innovation will change within a 'wild' location and researchers must identify the potential implications on the design for that environment (e.g. weather, physical safety, practical usage in context) which may change on a daily basis. When researchers maintained a sense of spatial acuity they developed an increased access to information tailored to students' locational and learning needs. This provided students with a greater immersion and affective engagement in the locational data and critical reflection on its meaning in context. However, poor accuracy in relating the information to specific locations could disorientate the students thus losing these benefits.

4.2 Temporal Acuity

Within a wild context such as a field trip, the flow of time in relation to that environment has critical importance, as learners' activities are often constrained by the amount of time available to them. The technology and the activity within that environmental context can either enable or inhibit the symbiotic flow of these two conditions, with the user, in that context. Of key importance for the researcher to consider is that temporal issues within a laboratory situation will be completely different to those within 'wild' environments and that they will need to review designs, activities and evaluation procedures to fit with these changes.

4.2.1 Temporal technology design

Many of the mobile systems used in the projects reviewed in this paper increased the speed and quantity of appropriate information that could be accessed up a mountain, in a quarry or on the streets of the city. Within both the formal learning contexts for the geography and geology students timescales were tight as the requirements for a field trip put pressure on certain activities being completed on time. This was especially true for the Mobile GIS project where students' activities were formally assessed as part of their degree. Many of the students anxiously noted the time it took to learn and use these devices whilst on a field trip:

> "But, I mean, all these things just take more time and like more knowledge of how to use the thing." (MGIS p18)

The researcher team often had to manage the tensions of technology limitations and learning time constraints whilst out in the field. This usually meant creative and innovative solutions by the research team thought up on the spur of the moment to deal with changing needs.

Within the OTIH project there was the extra consideration of information movement and overload between the two locations (i.e. between the field and the laboratory). The students realised different needs for the different locations and were remarkably astute in their consideration of the transmission of information to partners in the other location. The research team noted from video analysis of discussions between students in the field that they were themselves actively considering these issues before sending information:

> 'this will be interesting because I don't know which one we want to send back or how many we want to send back in one go' (1OT p4)
> 'We don't need to photograph this because they've had enough of that' (1OT p4)

Within system iterations, content management feedback and a parallel networking infrastructure tried to support a steady flow of information exchange (see Figure 5).

The use of technology to support information flow between the two locations was supported by mobile communication devices and systems. The use of a video stream provided feedback to those in the laboratory of how the students in the field were progressing. However, this was not a continual synchronous video feed. During the pilot trials it was realised that intermittent video images sent through still provided enough information to be valuable without slowing down the network connections too dramatically. At one point during the evaluation trials the research team noted that the images also triggered those in the laboratory going for lunch as they noticed their colleagues in the field had all stopped for lunch.

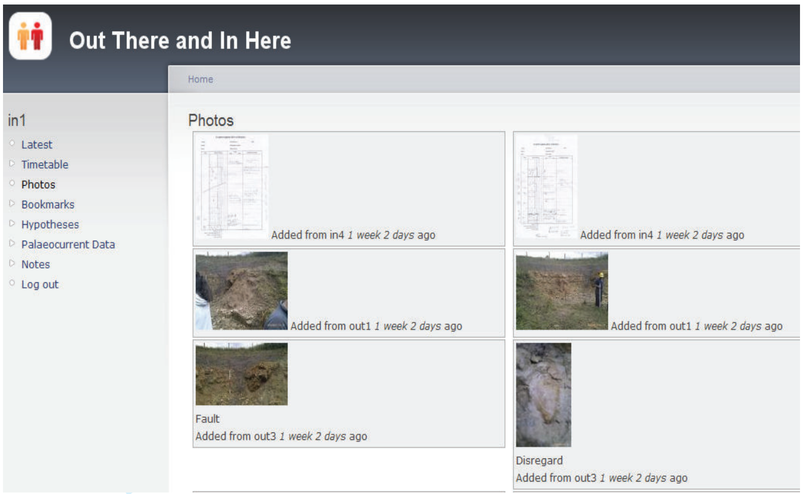

Fig. 5. OTIH content management system

Within the Hidden Histories project, participants found that the technology often gave them an additional control over temporal issues that they didn't have when in a person-led guided tour. For example the control over replay of commentaries when in the right location was noted as particularly useful by the participants.

Fig. 6. Mobile audio GPS tagged and accessed in the city in the Hidden Histories project

"You could replay the commentary if you wanted to re-listen" (HHp14)

4.2.2 Temporal activity design

The Mobile GIS project took a novel approach to geographical learning activities by asking the students to change their usual field practices and complete an expert walkthrough with the technology as a means of providing contextual geographic information in the field. This meant the students critically reflected on their own requirements and those of other potential target users in order to evaluate the technologies ability to meet those needs. The researchers noted that the students showed a remarkably shrewd perspective on the technology being open to innovation if it met their needs. Of particular interest was the students' acceptance of the fast changing capabilities of the technology and their expectation that there will in the near future be usable, efficient and cost-effective geospatially-aware information delivery systems available to complete these tasks quickly in context. The current technologies, although interesting, did not meet their expectations for usability and speed of access to information whilst out in the field.

The OTIH project maintained current field trip practices and sought to innovate existing learning design processes for field trips by technically supporting students in the field and in the laboratory with 'live' communication between the two locations. Built into existing activities was a requirement to share practical evidence collected in the field and abstract knowledge-based understanding obtained and analysed by students in the laboratory. The students had to vote on a collective hypotheses they had made as a distributed group. An orchestrated timetable for the students' actions was constructed to support the momentum of the whole activity across both locations. Scheduled meetings and sub-goals were co-ordinated between the groups. However, during the trials it was realised that the flow of time occurred very differently in the two locations. In the field, where the students were dealing with environmental, technical and sensory information, time flowed very quickly. Within the laboratory, where technology ran smoothly and sensory information was diminished, students highlighted how time seemed to flow slowly whilst they were waiting for, or researching data received from the field. The following quote highlights how the students indoors who had time to think in-depth on an issue were often frustrated by the team out being 'slow' in their cognitive thinking processes and responses:

Everyone at the tabletop In Here (IH), looking closely at a bridge site image, the, phone rings, B answers and exchanges greetings with the Out There team (OT).
OT: "… you should have a close up of the rock face here and our hypothesis."
A and C look at the Latest Updates projection
B: "Uh we have a hypothesis that this is sedimentary rock, which we've agreed with, we've actually put up another hypothesis, which... we think its oolitic limestone"
OT laughs: "Great!"
Discussion about what has been received and sent. Pleasantries are exchanged and call ended.
B: "God they are so slow out there!" *laughs*
Participants return to looking at images on the tabletop

Review of the video in both locations identified that the out there teams were often distracted by environmental issues which distracted them from in-depth thinking about the data collected and hypothesis made. Because of this difference in the flow of time, the synchronous orchestration of activities across the wild and laboratory location became very difficult to maintain and ultimately unproductive.

Throughout the OTIH trials it was realised that both locations valued the active 'live' experience even though this wasn't a synchronous event. The research team were flexible in their response to these changing needs and adapted the timetable to allow key points of interaction between the two locations when both teams decided they were required to complete a task. This flexibility in the research team allowed students in both locations to benefit from the different 'flow' of time in those locations. In the lab they participated in the engaging speed of how fieldwork time flowed, in the field the students benefited from capturing moments of the slower reflective time flow from the laboratory (see Figure 7).

Fig. 7. Group focus around mobile technology (smartphone and tablet) in the field

Often, a key question from the laboratory, or piece of information sent to the field tablet brought the field team together to instigate a discussion of the issues amongst the whole distributed group:

For Peer Review

> "So you do it on your own and then you form a group; trying to do it as a group is possibly more of a challenge… and I think we got that as time went on." (2OT p1)

Within the Hidden Histories project, the sense of time was very strongly connected to the location being public. Participants focused on issues related to their activities in a public space being acceptable or unacceptable to the rest of the general public present in that vicinity. This increased sensitivity to time factors was found to impact negatively on the design of learning activities within these locations. In particular, the length of the audio clips listened to by participants whilst found to be acceptable when reviewed in the laboratory were noted as too lengthy in the field. Again the flow of time appears to be faster in the wild than in the laboratory where the system had been designed and tested.

> "The individual segments were too long. You ended up standing still for a long time, feeling a bit conspicuous at times!" (HH p4)

4.2.3 Summary

Many of the mobile systems used in the projects increased the speed and quantity of appropriate information that could be accessed up a mountain, in a quarry or on the streets of the city. The technology for information sharing supported critical reflection, both in terms of what information/data to share and also when allowing the participant to repeat the activity as often as required. However, in the Mobile GIS project, students' expectations of technology usability were not met by the systems that took too long to learn. In OTIH, support provided through orchestrated and scaffolded activities was not initially flexible enough to allow for the different flow of time in the different locations. However, with a responsive change to the activity design, students benefited from dipping into the different temporal flow streams for the two locations: the field students experienced slower reflective time whilst the lab students engaged with speedy decision making and information capture.

4.3 Socio-Political Astuteness

It is important to understand that within 'in-the-wild' technology and activity design, the researcher not only has to balance users' interactions and perceptions but also those of different stakeholders that they may be working with. The researcher is required in their role to balance the needs of different community groups, user advocates and industrial investors' interests. It could be argued that research that aims primarily to innovate can avoid many socio-political issues by aiming not to support sustainable change to practices or systems. However, the researcher will still need to establish expectations regarding the value of the research and their contribution to it, particularly with respect to research funders, the broader research community and the aforementioned stakeholders.

4.3.1 Socio-Political Technology Design

Both the Mobile GIS and the OTIH projects actively sought to innovate with the technology whilst maintaining hooks into separate streams of sustainable development. For the Mobile GIS project, this resulted in using the widely-available Layar mobile phone app as a replacement for the original acetates. The OTIH project sought to develop flexible systems to support field work learning through collaboration both across and between different locations. However, although innovation was the initial approach taken by both these projects, the students were eager to provide feedback on routes to valuable sustainability and scalable systems. What was surprising was the ease with which they expressed socio-political astuteness in those developments. For OTIH students, the phone applications were noted as provided poor collaborative support because of the small size of images that could be captured and shared with others at the same location. Despite the difficulty of carrying a larger sized tablet, students in the field were very positive about these devices for the presentation of information to the co-located group. This also enabled quick and effective communication with the distributed group. With the addition of a touch-sensitive cover, these devices quickly became a focal point for collaborations in the group, whilst the smartphones remained personal devices primarily used to take photos and share them remotely. It could be that the success of the tablet device as a social device for the field lies in its similarity to the clipboard traditionally used for sharing field information.

For Peer Review

Fig. 8. Personal smartphone usage compared to sharing through the tablet

Within the Hidden Histories and Mobile GIS projects, the social space itself had an important impact on the design of the technology. In Hidden Histories, the use of smartphones in the city by the participants was noted as innovative but this location also posed some safety concerns. The tours took users to the older parts of the city which had narrow, dark Victorian streets:

Fig. 9. A narrow dark street used as a stopping point in the Hidden Histories project
[left image courtesy of Thom White, www.thomwhite.co.uk]

Within this location, participants noted a sense of unease at using what they saw as high technology:

"It was interesting and high-tech. Looked nice. Wouldn't have been good to be mugged." (HH p1)

Even whilst walking up a mountain where there were far fewer members of the general public in the immediate area, Mobile GIS project students expressed concerns about how they were viewed whilst using these devices. One of the students noted of others that they:

"didn't want to be walking about with things on their heads and they found it, I think they classed it as weird or something along those lines… they were also quite keen on the portable small devices – [they were] user-friendly and less obtrusive" (MGIS p9)

These students also went on to highlight key issues with regard to sustainability of the technology. They discussed the technologies that they used personally, mainly in terms of the cost of different smartphones, which they considered to be appropriate devices that could provide similar augmentations to those used in the Mobile GIS project. The VR head-mounted display was thought of as fun but not a realistic solution for mass use. The Hidden Histories participants also debated the tension between innovation and the sustainability of the devices they used:

"The tech was too high-tech, not everyone will have smartphones in 2 years time – you should still consider "basic" phones with SMS/WAP capabilities" (HH p3)

The project researchers emphasised the innovation and developmental aspects of this project to participants. However, the participants still compared the devices with standard off-the shelf systems expecting the reliability and stability that typically accompany these:

> “English Heritage have a very simple system - just press buttons. Couldn't even find volume controls [on this device]! The English Heritage one goes round your neck - very useful.” (HH P3)

This meant again that the participants were continually comparing the devices with other, similar technologies, with an emphasis on practical, sustainable solutions.

4.3.2 Socio-Political Activity Design

Both the OTIH and Mobile GIS projects were couched within sensitive political contexts with regard to field work in the learning process. Field trips are very expensive yet a highly valued part of the geoscience learning process. As such, increasing the value or scalability of these experiences has strong implications for the disciplines as a whole. This means that any development within these contexts will be scrutinised closely by stakeholders from any of the disciplines that use fieldwork in the learning process. This can cause tensions for the researcher, as they are continually encouraged to turn innovation into sustainable solutions. Criticisms can be levelled not so much at the innovations achieved but more at the lack of routes to immediate scalable, sustainable solutions. All the researchers within these projects felt the weight of this tension.

Researchers within the Mobile GIS project dealt with this tension by feeding directly into the formal learning process for the Geography department that offered the field trip module. The OTIH project developed further systems with community groups for informal as well as formal learning. However, the role of the researcher in collaboration with community groups, though immensely beneficial, was again found to be complex and requires careful management by the researchers.

The Hidden Histories project engaged with a local community history group, who possessed a specific socio-political approach known as ‘radical history’. The group focused on how life and living conditions were experienced by the working classes or ‘common people’ throughout history with a certain bias against ‘the ruling elite’ and law enforcement in general. During instances on both walks, these points of view were expressed, either intentionally or not, through comments in the spoken narrative. The technology used to communicate this information made these historical accounts more accessible than would usually be the case and the participants responded quite emotively. However, the participants in the two different walks reacted quite differently to this. In the person-led walk, this was seen as an amusing aside; “I invariably will side with the 'mob' against the ruling class!” HH p9. Feedback from the participants on the technology-led walk detailed that they felt the audio clips contained uncalled-for ‘jibes’ at Community Police officers and ‘the fictitious figure’ Robin Hood whilst other aspects of the narrative and the interpretations themselves were criticised for being ‘patronising’ and ‘middle class’. The researcher team was placed in a position where they had to unexpectedly calm concerns from participants on the technology-led walk, which related to ideological perspectives rather than technical issues. This example reveals the sensitive position that HCI researchers can often find themselves in when working in ‘wild’ locations. Often the technology or activity they seek to evaluate acts as a boundary object that can facilitate the movement of ideals and political ideologies quicker than traditional media. As a boundary creature, the researcher can find they are unaware that they are perceived as facilitating this transmission of ideologies which have nothing to do with the research at hand.

4.3.3 Summary

There are many potential benefits from researchers developing socio-political astuteness within a project. However, within these aforementioned projects it often meant pushing towards other objectives which the researcher then had to balance. From the social end, the participants noted benefits for field-based learning activities of shared social devices (e.g. tablets) rather than personal devices (e.g. smartphones). However, the social context for the device usage was found to increase their inhibitions and decrease their sense of safety.

The desire of participants and stakeholders to develop sustainable versions of the systems was expressed in design meetings and evaluation reports. However, the most difficult balance was in relation to collaborating with community groups as project stakeholders. These stakeholders can retain ideological approaches that when instantiated within the technology can make the researcher

For Peer Review

appear as an advocate and champion of those approaches rather than the technology and techniques of the trial.

5. DISCUSSION

The research findings identified 3 key perspectives that the researcher as a boundary creature had to develop in the design, deployment and evaluation of field based learning systems: spatial and temporal acuity and socio-political astuteness. Researchers within the projects found that reflection on these perspectives and a reflexive review of how they interact within the design, deployment and evaluation processes (through the RDR model below) provided a mechanism to manage their boundary creature role within future interactions. As one researcher noted, “I’ve often had to deal with these tensions but never had the appropriate language to articulate it or legitimise it; this gives me a starting point for managing expectations within the research process.”

The analysis of these three projects presents evidence around researchers working in the wild as boundary creatures needing to acquire some quite concrete acuity skills. As a boundary creature working in the wild, they must remain aware and be sensitive to spatial issues and tensions that can occur in the research process. Within these field-based learning projects, these spread from the quite simplistic concerns of managing technology in different weather conditions, to complex safety issues as students immersed in a virtual representation forget they are near a cliff edge in the real world. These could have ethical ramifications as people could become disengaged from physical locations and the subsequent consequences of this in their physical reality. Suchman [2011] notes how the use of game-like visualisations in military systems can support users’ detachment from the implications of their actions in a real space. As researchers working across the boundaries of communities, we have to be reflexive about our actions and the implications of the technology we develop.

The findings also identified that researchers need to acquire a sensitivity and awareness of temporal issues that could impact on the research. The findings highlighted, in different ways across the three projects, there was a different flow of time in the laboratory to that within the wild. As already noted, Marshal at al. [2011] identified through their own reflexive accounts of their personal spatial acuity within the research, how collaboration in the laboratory was completely different to that within the wild. The researchers in our studies identified how students felt this change in time impacted negatively on their engagement with the activities and the acceptability of the technologies. Within some cases, however, the researchers developed this temporal acuity and adapted the design of the activities and the technologies to allow the students to gain a better temporal flow.

The researchers’ ability to develop spatial and temporal acuity could be argued as the first step in allowing the participants to become immersed in the research experience and develop an enchantment and affinity for the technology and the activities. Wright et al. [2008] review the concepts that make an aesthetic experience and highlights the importance of ‘enchantment’ (i.e. being charmed and delighted), saying that this relates to the element of being ‘caught up’ and ‘carried away’, characteristics that are often related to the concepts of ‘flow’ [Csikszentmihalyi 1990] and ‘immersion’ [Sanders and Cairns 2010]. Wright et al. [2008] note a framework for five sensibilities that supports design for enchantment. We summarise these as: *object sensuousness* involving the user’s intimate engagement and absorption with the object within a specific place (spatial acuity) and time (temporal acuity); *holistic engagement* for the whole intellectual, emotional and sensual person; *being-in-play* is about allowing the user to enjoy the whole moments of play; *fuzzy flexibility* where the user accepts paradoxes, openness and ambiguity; finally *transformation*. Wright and his colleagues see transformation both as a site for initiating enchantment and also as a product of the enchantment. Jordan [2010] reviews the related concept of affinity in design also relates to concepts of identity and the self. In particular. this paper highlights the notion of how the design of technology can fit with temporal perceptions of how we see ourselves now, in the past or the future, with an affinity to both nostalgic and aspirational designs. Researchers as boundary creatures in the wild can support or inhibit personal transformation.

Brydon-Miller and Maguire [2009] present arguments, framed from a practitioner inquiry perspective, proposing that research can never be neutral as it is always located within a social, political and economic context. This can be identified within the results from all three projects documented in this paper, which are couched within the current world economic crisis. It is not surprising then, that the students’ comments frequently turned to the cost of devices or applications and the potential to be mugged with expensive equipment. The Mobile GIS and OTIH researchers also noted the pressure placed on them within the current climate to turn these systems into scalable solutions to reduce field-work costs. Socio-political issues presented the users and researchers with a wealth of tensions to manage. Whilst the students felt self-conscious wearing fairly obvious head-mounted displays in public situations, the researchers felt uncomfortable when they realised they had unwittingly allowed community group stakeholders to use the technology as a boundary object to more effectively communicate their political ideology. It was noted by the researchers that an earlier reflection on the different parties' expectations and astute reflexive account of how this may be reviewed in the wild context may have countered this oversight. The design cycle for practitioner inquiry has strongly built into the process these reflection points. With a simple connection between different communities use of language this can be translated into computing / HCI terminology (see Figure10).

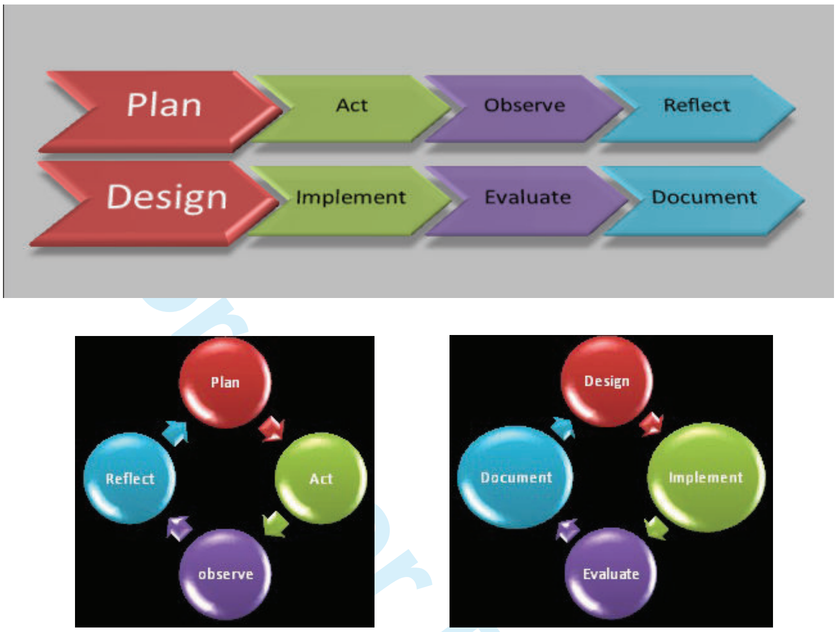

Fig. 10. Practitioner inquiry cycle mapped onto HCI research cycle [adapted from Reason and Brandbury 2001]

It is important to note that through translating the practitioner inquiry cycle into a HCI frame of reference that the different potential starting points for initiating a research project become apparent. Within HCI, the researcher could start with the implementation of a system that is then evaluated, or from an ethnographic approach the researcher could start by observing current practices in the wild.

As HCI researchers, we step across boundaries physical, social, psychological and political. We need to become reflexive in our commute across these boundaries so that we are aware of the issues that we may encounter in this journey. Supporting stakeholders and the research teams' awareness and understanding of the research process we envision can support the process. A focus on developing temporal and spatial acuity as well as socio-political astuteness is a useful evolution in our development as reflexive researchers. The practitioner inquiry cycle also provides a useful guide to different cycles through the research process. However, these do not support the researcher or stakeholders in framing expectations for the research aims and goals.

Using the practitioner inquiry approach and the evolutionary / revolutionary design process concepts [Adams et al. 2005], a secondary analysis of the researchers role within the research cycles of each project was completed (see Figure 11). The analysis was used to develop an 'in-the-wild' model and theory of the researcher design role (RDR) in that process. The RDR reveals that there is a continuum of two tensions researchers manage during their field based learning research. Firstly, they dealt with expectations and the reality of whether the technology or learning activities were led by innovation or scalable solutions and sustainability in the design and deployment process. Secondly, was the project seeking to use the technology to maintain or change current practices? This then can alter perceptions of the user as they perceive the system as 'changing practices' to those that are unworkable or insightful. In contrast, the user could perceive a focus on 'enabling current practices' as facilitating or threatening those practices. Alternatively, a push on the importance of scalability and sustainability can be thought of as either facilitating long term practices or changing those practices for good.

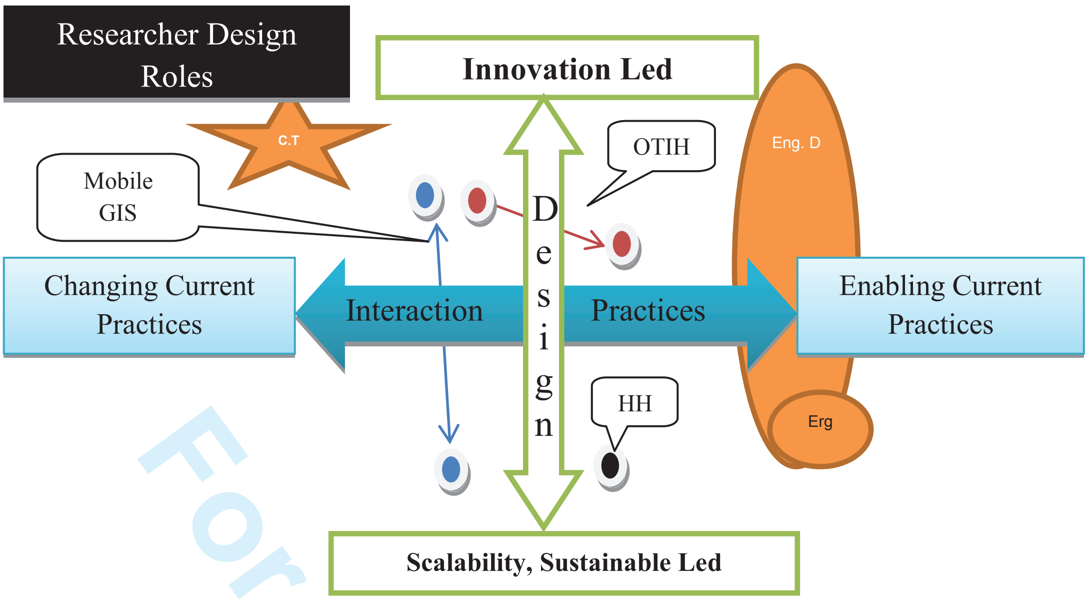

Fig. 11. Research design roles: mapping tensions researchers manage in the HCI field based learning process (CT= catwalk technologies; Eng. D = engineering design; Erg = ergonomics)

Within each project, not only did the research start at different points in the research design role (RDR) process, but they were also framed within very different expectations around each of the issues. Both the Mobile GIS and the OTIH project sought to innovate with the use of technology and within the learning activities. They also sought to change learning and technology usage practices. For example, the Mobile GIS project used virtual and augmented realities for field trip activities where geographers took on learning about their practices through critiquing the technology for those tasks. The OTIH project used an ecology of information systems, recording and communication devices across different locations and used a distributed reflective process to support live reflection in the field and the laboratory based on hypothesis generation and a voting system. The Hidden Histories project, however, aimed to make current systems and history learning practices, in the field, more effective by introducing mobile systems that are far closer to becoming scalable and sustainable that the systems in the other projects. The expectation behind this project was never to totally innovate the technology for history learning in the field, nor to totally change how the public interact with historical accounts. For example, members of the public were not expected to sing and dance accounts as historical characters from the era. Developing scalable, usable and sustainable systems was a core objective of the research team. However, the participants in the project and the community group stakeholders saw this project as innovating both through the technology and through the learning. The participants and stakeholders in the Mobile GIS and OTIH projects realised that these projects aimed to change practices and innovate technologies. However, those within the academic institutions supporting this research pushed the researchers to developed scalable and sustainable systems. The Mobile GIS project dealt with these needs by producing computer printout acetates (that were both scalable and sustainable) whilst still innovating around the field based learning practices; this then led to an innovation with 'electronic' acetates which now is currently feeding back into a scalable mobile application (Zapp, mentioned in section 3.2). The OTIH developments initially focused on 'changing practices' and later in redesigns on 'enabling current practices' enhancing links into the scalability and sustainability of systems.

Figure 11 also highlights the position of catwalk technologies in the RDR process. Catwalk fashions actively seek both to innovate in the materials used and in how they used by the models. They also seek to change our practices with what we wear (i.e. what is a dress, what are shoes – beyond being functional). Often the fashions designed focus purely on creativity and innovation and result in products that are not functional, with shoes and clothes that are barely wearable for more than a few minutes. Like catwalk fashion designs, catwalk technologies may not be able to be used in the wild for very long or very effectively. The technology may not provide a full

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application (as in a 'Wizard of Oz' approach) or provide technical stability without a lot of support. The activities may also be too labour intensive to provide long term sustainability. This approach is simply a route for creativity to provide a pure absolute proof of concept. When reviewing the concept of a catwalk technology, it is important to note that this is useful only as a step in an iterative design process in moving forward a research group, discipline or institution. A pure catwalk technology seeks to innovate in both the technology and the activities they are used for. However, the iterative move from catwalk to prêt-à-porter (ready to wear) systems is often where HCI systems sits. Through usability evaluations, we seek to establish hooks into how to make the system scalable and sustainable. These systems can either seek to maintain current practices or actively seek to change them[1]. When placing these theories within a HCI context it is useful to refer back to the tensions documented by Wolf et al. [2006] between the creative design-oriented approach and the engineering design approach. Catwalk technologies would represent the creative design-oriented approach. Within the RDR framework we can also place Wolf et al.'s [2006] conception of the engineering design approach (see Figure 11). Ergonomics, specifically man-machine interaction (the predecessor of HCI), actively sought to research and support workers' current practices on large scale systems. The engineering approach to HCI and related methods (e.g. task analysis) has taken this forward and developed innovative technologies and approaches to the activities used. As Wolf et al. [2006] argue, all these approaches are equally valid and the model we present is useful only as a way to theorise and manage expectations that researchers encounter from different research stakeholders. Our model is also currently based upon a very narrow set of 'in-the-wild' field based learning trials. Further research is required to expand and verify these theories.

6. CONCLUSION

As already identified in the background literature, Haraway [1991] connects the concept of boundary creatures with those of being outside of the norm and monstrous. Within the 'in the wild' projects we have reviewed here, we have identified the notion that we are all at some time or another 'demonstrating' perspectives that are not the 'norm' for many; rather, it is possible that we as researchers are the monsters who threaten that community. Both Wolf et al. [2006] and Rogers [2011] are reviewing epistemological changes in approaches within HCI that could be considered 'horrific' and monstrous to some. However, as technology and its design moves forward at an ever increasing speed as HCI researchers we need to develop reflexive approaches to our work and how we see ourselves to enable us to become insightful brokers [Burt 2005].

We therefore need, as HCI researchers in the design process, to review our identity within that process. HCI as a discipline has for many decades been finding its theoretical feet within the specific confines of the research context. The wild initiative is taking us into bold new frontiers where we can cross, through our creative designs and reflections, established boundaries. We can become explorers and bring home to HCI, through boundary crossing, experiences from foreign lands. Or we can establish ourselves as a boundary creature where we empower HCI as a discipline by owning the transition between domains. To do this we must understand our identity as boundary creatures. This means not only within regard to the participants or other stakeholders but within the socio-political standing of the research. This requires an understanding of our expectations for the research as a catwalk technology or a scalable sustainable system; whilst also understanding ourselves within the context of the institutions we belong, the funders who sponsor the research and the policy makers who instantiate the research within a sustainable format. In facilitating the move from innovation to scalable and sustainable designs, we can proudly take on the role of boundary creature transforming catwalk technologies or the innovations for current practices into ready-to-wear systems. To do this however, we have to take on the mantle of being considered as both horrific and empowering.

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[1] It is worth adding that the intention of enhancing or changing practices is only in reference to the initial objectives of the designer. In deployment of the technology how the system actually changes practices is another issue.

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