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. Tensions often relate to expectations around current and future roles of the technology development. We propose a catwalk technology metaphor where researchers as boundary creatures focus on innovation whilst providing links to prêt-à-porter (ready to wear) developments. Evidence from 140 participants, within three 'in-the-wild' field-based learning case studies (for mobile, distributed, sensor and augmented reality systems), conceptualise the researchers' 'boundary creature' role in managing design process tensions. Stakeholders, including participants, expected the research projects to produce ready to wear (prêt-à-porter) boundary objects for current practices even when researchers sought to take catwalk approaches by innovating technologies and changing practices. The researcher design role (RDR) model articulates researchers' narratives with the design team, stakeholders and users around what is innovated (e.g. technology, activities) and how the intervention changes or sustains current practices.

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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 stand 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 HCI researchers working across these different social, physical and technological boundaries we can easily be thought of as both bizarre yet also empowering. To enable the latter perception we need to understand our own role in the research and design processes as we traverse these boundaries. Much of this comes down to stakeholders and research participants' expectations for the technology as a boundary object and how we communicate our shared expectations for the research.

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

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with them. Our sense of control over a context could therefore be considered as one attribute defining an 'in-the-wild' study.

Within geoscience and history, the field trip can present a context that is perceived as 'in-the-wild' by both learners and HCI researchers, developing and evaluating technologies. However, often some stakeholders such as teachers and community organisations are in their 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 and / or the 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. They also need to support the design of boundary objects and related practices that translates across these boundaries and communicates expectations for these boundary objects.

It could be argued that these issues are important to any design process 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 processes. Many within the domain of educational 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-à-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 practitioner inquiry and grounded theory perspectives.

2. BACKGROUND

The 'wild' context can act as 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. 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 researcher's place in that process). Thus, this describes a shift in HCI research from a task driven approach to one that focuses on experiences, and creative, often serendipitous inquiries. This relates strongly to Bødker's notion of the third wave for HCI being more context and application focused [Bødker 2006]. Research into experience and cultural inquiries has been explored in particular by Gaver et al, in their research into 'cultural probes', which sought to elicit qualitative information from users around designing for pleasure and drawing upon users' own feelings and experiences in their everyday lives [Gaver et al. 1999; Gaver et al. 2004]. However, as mentioned by the authors themselves, this approach is a very individualistic one that does not try to provide a way in which the resulting feedback can be aggregated to give a list of design requirements; indeed they criticise those whom have attempted to use it in this way. As such, this is not a particularly scalable technique but rather one that can give unique insights and justifications for specific design decisions made by the researchers' subsequently.

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's 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. 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's Role in the Research Process

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. Both the researchers conducting the research and the project participants develop their own identities 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 2013]. 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. Adams et al. [2008] detail the particular importance of reflexivity in a qualitative HCI approach.

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).

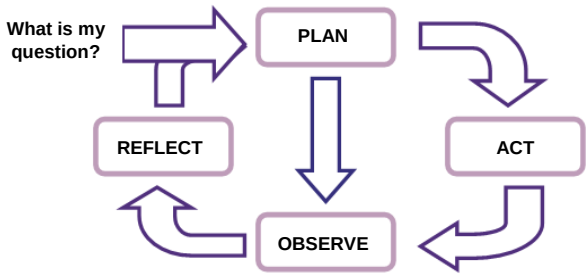

Fig. 1. Practitioner inquiry cycle [based on Reason and Brandbury 2001]

2.3 The Researcher as Boundary Creature

In this section, we review the notion of a HCI researcher identity being closely related to that of a boundary creature negotiating crossings between different communities and contexts. Johnson et al [2012] detail 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, 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 relation to the HCI researchers' role. Our identities are not fixed commodities that can be simply traded up or down after learning occurs. For all tasks 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 as applicable to task [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 work now so I'm an employee, I'm home now so I'm a daughter / son / mother / father'. However, our identities, lives and our roles in the research 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]. Development of a research identity 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].

Ultimately it is essential that as a HCI researcher we consider the type of boundary creature we are seeking to be. Should the HCI researcher be spanning across several boundaries in the design process, or crossing specific boundaries as and when they are required or sitting within the boundary space facilitating translations between spaces and communities? Whichever role we take on, there are technical and socio-political repercussions from each approach. Donna Haraway [1991], the feminist scholar and historian of science and technology, presents the 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). This shows a definite role of crossing boundaries into other communities. Burt [2005] in contrast highlights the value of becoming a broker between social worlds where we can gain social capital by presenting creative insights and possessing a genius born out of the import-export of ideas. This presents more of a boundary-spanning role, although it could be considered that the researcher resides at or within the boundary and steps into different communities when required.

As HCI researchers in educational research-led processes we translate and transfer 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 have a history of evoking emotive responses as the balance between creativity and standardization are maintained [Bernstein and Solomon 1999]. It could be argued that HCI researchers need to provide flexible support to these affective responses when balancing 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 boundary object translations and how the researcher can use reflexive processes to balance those tensions.

2.4 Technology as Boundary Objects

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. It could be argued that, from this perspective, knowledge is a translation between these factors. Technology as 'boundary objects' often traverses these knowledge domains and social structures, and supports 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. This could be thought of as the translation properties of a boundary objects. Some objects facilitate knowledge sharing and understanding across boundaries. Technology probes [Hutchinson et al. 2003] can be seen as an example of boundary objects, since they traverse both end-user and researcher communities, whilst also investigating scalable – or at least user-friendly – technical innovations.

Some boundary objects become barriers for users moving between communities as they may be embedded in local jargon, informal practices and unfamiliar norms of behaviour. Their ability to support translation for the boundary object practices is therefore inhibited. 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 (i.e. boundary object practices) 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. As HCI researchers aiming to support the translational properties of boundary objects we must first consider boundary object practices and then reflect upon our role as a boundary creature supporting the design of these objects.

When reviewing boundary object practices in the wild there are several hierarchical and ontological models that review the concept of ecologies with regard to resources and devices [Luckin 2008; Nardi and O'Day 1999]. Many reviews also note 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, as 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 and boundary object practices in those contexts. Nerb et al. [2007] highlight how time factors increase the importance of ordering complex tasks, to increase the potential from a boundary object 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 and technically mediated boundary 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 the design of technology as boundary objects for 'in-the-wild' research. 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 spaces in the wild as distinctly different to that of the laboratory. Schiphorst [2011] explored the use of garments equipped with sensors to promote self-awareness, relating transformations of the self and our own state to the physicality of the somatic (corporeal) self rather than the visceral (perceptual) experience. Other forms of wearable technology aim to offer participants a sense of presence in a computer-generated virtual environment as with Virtual Reality (VR). As an effective boundary experience, this must utilise multisensory immersion to increase the breadth of information available to participants as summarised by Steuer [1992]. Similar technologies can be used to fuse elements of a virtual environment with a real world scene as with outdoor Augmented Reality (AR) systems as described by Avery et al [2010]. Whilst there are many application domains for these technologies (such as rehabilitation, planning or landscape reconstruction) these remain complex systems with many technical and HCI challenges to tackle in exploiting their potential as boundary objects. However, this still leaves the question of our role in designing boundary objects and related practices.

As HCI designers we need to reflect upon our role in designing boundary object practices and their translation properties. In particular, as already noted, we should be considering our role in spanning, crossing or residing within the boundary where the object resides. 'In-the-wild' research has uncovered several directions of value to the researchers' reflective processes [Sharples 2000]. However, when considering our role in the design process it is essential that we consider expectations about the type of design process we are aiming to achieve. Do all the project researchers have the same expectations and how do these correlate with the different project stakeholders?

2.5 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 conversion of data values from one format or system 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 innovative changes which may not be acceptable and thus sink into oblivion.

They argued that technological progress consists of a well balanced mix of these two design approaches. In particular, their 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 did not fall within the scope of this research is that of the researchers' own role in the design process.

Within the HCI domain, research into online communities has taken many theoretical approaches 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 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 the visionary producing personal transformations, but this elite design process can also influence everyday consumption. 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 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] gives 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 these approaches are not mutually exclusive and are both valid.

If we view wild technologies through a fashion design lens we can see a theory for a '*catwalk technologies*' approach to design processes whereby innovation leads the development process whilst also providing hooks for some iterative, scalable and sustained technology design processes. 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 concurs with Rogers' [2011] arguments around the prototyping of innovative technologies in wild settings.

3. RESEARCH METHOD

There are various approaches to research evaluation that can elicit understanding. Patton [2002] and Merriam [1998] argue that case studies, in particular, provide a holistic, in-depth, and context-sensitive picture of what is being researched. This appears to be a wholly appropriate approach to take for an analysis of in the wild research. Stake [2005] has classified three types of case studies: intrinsic, instrumental and multiple. The intrinsic case study focuses on a particular intrinsic interest rather than trying to understand a generic phenomenon. In contrast an instrumental method uses the study to understand some external phenomena that is further studied from

different perspectives and contexts with a multiple case approach. Lastly, Noor [2008] argues that examining multiple cases can enhance the accuracy, validity and reliability of the results. These arguments provide the rationale for our multiple case study approach to understanding the generic phenomena of the researchers' role in a wild design process.

A core focus of our research examines the context of both the researcher and technological innovation in relation to practice. As such, our selection criteria for the case studies chosen were based upon:

- The projects being in the wild and practice-based.
- Novel technologies being developed in the wild, in relation to practice.
- The projects were concerned with changing practice, rather than just maintaining it.

The criteria for case study selection was based upon its applicability for in the wild design processes as documented by Rogers [2011] i.e. developing novel technologies in-situ, changing or even disrupting practices.

The resulting set of 3 studies covered a range of different technologies for geoscience and history learning, for a variety of different types of users. These were 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 the streets of a city. The research design processes (i.e. design and development of technologies in the wild) ranged from a 6 month to a 6 year period, and results from users – university students, school children and the general 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.

From these case studies we sought to identify the role of the researcher in the design process. This required a reflexive approach from the researcher and to facilitate this, a practitioner inquiry approach was taken within the data collection process.

3.1 Data collection and analysis

Participants for the studies were recruited through both direct and indirect means. In the formal learning scenarios (studies 1 and 2), participants were pupils or students engaging with the studies through their day-to-day educational activities, and recruited directly by researchers working with their teachers at the respective educational institutions. For study 3 (informal learning), participants were recruited via direct or indirect contact with either the community group or the researchers of the study, or through serendipitous means (i.e. from having seen promotional material through posters or on the Internet). Ethical clearance was obtained before each study commenced and users gave their informed consent before participating.

Participatory design was a key component of Study 1, but was much reduced in Studies 2 and 3 where the researchers themselves took on the role of the design of the technologies and the ways in which they were deployed.

Data for each study were collected through mostly qualitative approaches. Details of these approaches are provided in subsequent sections (3.2.2-3.2.3): they involved participants' video diaries; researcher observations; video recordings of user trials; questionnaires; focus groups and interviews with participants.

Field notes taken by researchers throughout all the projects were also analysed to provide additional insights into the design processes, particularly where comparisons between researchers on the same project could be made.

This paper takes an approach to the research which merges grounded theory and practitioner inquiry. Practitioner inquiry provides an overarching theoretical perspective on the evaluation process appropriate for technology enhanced situated learning, whilst grounded theory [Adams et al. 2008] provides an analysis approach that helps us to link together the case studies detailed in the following sections. The age range of participants varied on each project: for studies 1 and 3, participants were between the ages of 15 and 62 years old, although the majority were adults. For study 2, all participants were university students, typically aged between 19 and 32 years old, with the majority around 20 years old. Likewise, gender was also mixed in all three studies, with no particular bias towards males or females.

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).

It was decided that rather than taking an auto-ethnographic approach [Cunningham and Jones 2005; Cunningham et al. 2010] to the data collection and analysis that focuses 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 6yrs. 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. The case studies initially underwent a thematic analysis to code and group concepts identified throughout the data. This analysis and the raw data was then methodically reviewed to re-code those concepts within a grounded theory open coding stage which linked concepts from across the cases. These were then systematically abstracted into selective coding relationships with a hierarchical order that supported identification of a high level story-line the final goal of a grounded theory analysis. 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).

3.2 Case studies

This section provides details for each of the three case studies. Table 1 below summarises the main characteristics of the different studies andsites, with further detail provided in the text following the table.

Table 1: overview of the different studies analysed in this paper

Study:	**Field site focus:**	**Task focus:**	**Participants:**	**Technologies used:**	**Mode of evaluation:**
1: Out There In Here	Quarry	Undergraduate geology fieldwork	Requirements: 19 geoscience academics and postgraduate students; Evaluation: 21 geology undergraduate students	Interactive multitouch tabletop; smartphones; laptops; video camera; live synchronous feed and Internet connectivity.	Questionnaires and focus groups (in sub-groups and as a larger whole group); log analysis from tabletop, mobiles and online chat; debriefing session for researchers and other stakeholders.
2: Mobile	Landscape (Lake	Undergraduate and	Over 120 geography	Acetate-based augmentation;	Video diaries, researcher

GIS	District, UK)	postgraduate geography fieldwork	undergraduates and Masters students	PDA (Personal Digital Assistant); tablet PCs; smartphones; in-field Virtual Reality with HMD (Head-Mounted Display); various multimedia.	observations and focus groups.
3: Hidden Histories	City centre (Nottingham , UK)	Historical/ heritage audio walkthroughs	56 members of the general public	Smartphones; audio files.	Questionnaires, researcher observations and group interviews.

3.2.1 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 participants 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 geoscience academics 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 undergraduate geoscience 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 Survey 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 participants were able to vote on whether they agreed with these or not.

The participants 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.

3.2.2 Study 2: Mobile GIS

The title Mobile GIS (Geographic Information System) is used to describe a series of practical fieldwork activities carried out by students from the School of Geography at the University of Nottingham from 2007, underpinned by fieldtrip projects dating back to 1997. The exercises leading up to the Mobile GIS project involved the use of wireframe perspective views derived from Digital Terrain Models printed into acetates to encourage students to compare digital models of landscapes with the real world scenes, and later adding other labels and annotation as shown in Figure 8. From 2007 an investigation of in-field digital technology began, where participants were asked to investigate how information about the landscape could be represented and visualised to support critical reflection on a landscape scene. The emphasis was on the design and placement of geographical content to be accessed in the field. The focus for the researchers was on the effectiveness of design elements across the range of techniques used, in terms of providing users with content that had relevance for their current situation. More than 120 students took part in the Mobile GIS exercises, initially first-year undergraduates and then later third-year and Masters level students.

The PDA-based application GeoMole was developed to deliver similar images as used in the acetate exercise, automatically triggered by GPS position, but relying on loose matching of the scene rather than through direct transparency overlay. GeoMole also featured an on-screen sketch facility and audio descriptions of landscape scenes relevant to what should be visible from any given point.

In 2009 the field exercise was able to utilise several additional techniques capitalising on some development work being undertaken on the SPLINT (Spatial Literacy in Teaching) project. Inspired by the use of individual technology probes [Hutchinson et al., 2003] an exercise was created which brought together a number of different technologies ranging greatly in their technical complexity, display hardware, media delivery capabilities and interaction design. This mix of affordances allowed the researchers to attempt to isolate the characteristics of techniques which were observed to be effective as boundary objects in delivering relevant information, and those instances where the technology became a distraction. In addition to the use of acetates and GeoMole the other three techniques introduced were:

- Google Earth running on a GPS-enabled tablet PC
- Mscape software [Stenton et al. 2007] running on mobile phones allowing a range of media designs to be authored and alternative locative trigger zones explored.
- A Head Mounted Display (HMD) using a visually immersive stereo visor-based screen and real-time geo-located interaction with augmentations [Jarvis et al. 2008] shown in Figure 3. Although cumbersome and expensive it offered participants an example of state-of-the-art technology which related to developments in wearable computing such as Augmented Reality (AR) eyewear of the sort later to emerge through Google's Project Glass in 2012 (https://www.google.com/+projectglass).

From 2010 acetates and Mscape were used alongside smartphone-based AR browsers, and in 2012 a single bespoke Android app called Zapp [Meek et al. 2013] was evaluated. This technique uses a line-of-sight algorithm to intersect a digital terrain model to query points on the landscape where the user is pointing the device.

Participants 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 each developmental iteration was informed, and critical reflections on our own practitioner inquiry were made.

3.2.3 Study 3. Hidden Histories

This project investigated the use of location-based audio to enable the public to learn about historical events, specifically the 1831 Reform Riot as it occurred in the city of Nottingham, England [FitzGerald et al. 2012]. 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, with the person-led walk being taken by 50 participants whilst the technology-led walk was tested out by 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.

4. RESULTS

Throughout the analysis of the data from the three studies there was a common high level storyline based on the need for the researcher to balance tensions when developing technologies in the wild that changed practices. These tensions often related to expectations around the current and future role of the research and the technology being developed. Stakeholders and participants often assumed that the researchers were aiming for the technology designs to become scalable and sustainable systems. There was also an assumption that the researcher aimed to facilitate current practices and that changing practices was simply a by-product of a poorly designed technology with a bad fit for their tasks or with the environment. Ultimately the stakeholders including participants assumed that the main aim of the research was to produce ready to wear (prêt-à-porter) technologies that fit with their current practices. However, within these case studies often the researchers sought to take a catwalk approach that would create and innovate with the technologies and change some practices.

The analysis produced three main themes from the case studies that relate to this high level storyline. The first theme was around the relationship between practice and technology design in the wild and in particular the issue of changing or maintaining current practices. Technology used within a wild environment often forced an unexpected change to practice, to manage the technology and information usage in that context. Forced changes to practices through the implementation of novel technologies or the orchestration of tasks often disrupted the participants' expected use and flow of time in the wild. A second theme examined the role of the researcher as a boundary creature supporting the design, development and evaluation process in the wild. The researcher often had to manage the practical usage of the technology and tasks within the physical constraints of the wild context. As a designer, developer and evaluator, they also had to adapt the system and tasks to the participants' changing technology and task needs. The researcher also had to move between different situations and stakeholders whilst adapting the system and tasks to their specific social norms. A final theme looked at the issues of technology design in the wild as boundary objects. The case study evidence highlights the researcher's need to manage expectations around scalable and sustained technology development. This relates particularly to the design and use of catwalk technologies and the move towards prêt-à-porter developments. Ultimately, the researcher as a boundary creature between different situations has to manage any discords to support a successful project outcome. For example, stakeholders' desire for scalable and sustainable systems can push developments in specific inappropriate directions. Some collaboration with particular groups may allow the expression of ideologies offensive or inappropriate to the users, which may appear to be championed by the researcher through technologies used as boundary objects.

4.1 Technology and Practice in the wild

According to Rogers [2011], in-the-wild research focuses on developing and evaluating technologies in-situ with technology opportunities changing and even sometimes disrupting current practices. As was noted from the research methods section the case studies were chosen

because they sought to use technology to change some of the participants current practices. The results documented here review those decisions within each of the wild case studies.

Within all the projects the technology provided increased access to information that was tailored according to the participants' current location and task needs. However, each project sought to change practices on how the participants acquired, shared and utilised this information. The Mobile GIS project developed a variety of augmentation methods that facilitated a novel approach to geographical learning tasks. The current technologies, although interesting, did not meet the participants' expectations for usability and speed of access to information whilst out in the field. However, the participants revealed an 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. Of particular interest from this research was the participants' acceptance of the fast changing capabilities of the technology and their willingness to adapt and change their practices to facilitate these technological approaches.

The OTIH project sought to innovate by changing the practices required for field trips by technically supporting students in the field quarry 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 hypothesis 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 this change to practices meant that the out there teams were often distracted by environmental issues which diverted 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 technological changed activity of a distributed 'live' experience even though this wasn't a synchronous event. The research team were flexible in their response to these changing needs in the wild 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. The research team quickly adapted the system design 'on-the-fly' to allow 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 2).

Fig. 2. Group focus around mobile technology (smartphone and tablet) in the field

This adaptation to the technology to in the wild task requirements mean that novel and valuable interactions occurred. 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:

> "*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, participants' interaction with the information was designed to be related to a specific physical location. Although this related strongly to current practices, for this public group it also dramatically changed the way that information was triggered by the location and not the participant. This allowed 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 history 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 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)

As with the OTIH project the Hidden Histories project also identified that this change in practice was accompanied by a strong sense of time was very strongly connected to the location, in this case with regard to it 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 the 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 a public setting. Again the flow of time appears to be faster in the wild than in the laboratory.

> "*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 Boundary creatures' role for 'in the wild' design processes

Within each case study when designing and developing the technologies and practices in the wild researchers had to become *boundary creatures*. The following results have identified that the changing roles of the researcher as a boundary creature can be defined within three categories: the physicality of the context (e.g. up a mountain, down dark streets in a city); participants changing technology and task needs (e.g. technical support, design recommendations, task specific support); or the social norms of that situation and related stakeholders (e.g. geoscience practices, collaborating historian group expectations).

The OTIH project sought to support innovative practices 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 3). The key point here is not simply that of lighting conditions for touchscreen laptops or iPads but the researcher as a boundary creature needing to carefully consider the environmental issues in the specification and design of the trials. The research team had not adequately communicated with suppliers with respect to specifying the technology requirements. A check-list of environmental conditions and pre-trials may have identified potential issues with the environment.

Fig. 3. 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 participants (i.e. geography students) to use 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 participants 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 issue by the researchers when the systems were further developed in the wild, up a mountain. The participants could not see the real world through the VR headset and so couldn't see where they were going (and thus were 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 reveal quite powerful sequences of students moving towards cliff faces as they explore the VR scene with researchers or fellow students stopping them before this became dangerous.

Fig. 4. 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)

Within all the case studies the researchers as boundary creatures found they not only had to take on the role of technology designers and developers in the wild, but also support and facilitate the participants' tasks. The participants in all three case studies completed formal or informal educational field trip tasks. However, the wild context for each study meant that the participants' times for the activities often felt to them very limited. Within a wild context the technology and the activity both enabled and inhibited the timely symbiotic flow between these two. At times the technology slowed down the activity processes whilst at other times the technology could move things faster than the task required the participants to go thus making them feel pressured by the technology. Of key importance for the researcher to consider in supporting these activities was that temporal issues within a laboratory situation will be completely different to those within 'wild' environments and that it was essential to take the approach of reviewing designs, activities and evaluation procedures in the wild to fit with these changes.

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 the field trips put pressure on certain activities being completed on time. This was especially true for the Mobile GIS project which formed part of a residential fieldtrip where the participants' tasks were formally assessed as part of their degree. However, the researchers often had to support the participants acquiring the skills to be able to utilise these devices appropriately. 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 as a boundary creature also had to manage the tensions of technology limitations and task time constraints whilst in the outdoor environments. This usually meant creative and innovative solutions by the researcher as a designer. Within the OTIH project the research team had also to consider information movement and overload between the two locations (i.e. between the quarry site and the laboratory). The research team noted from video analysis of discussions

between participants in the quarry site that they were actively considering information transmission and overload 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)

The researcher often had to switch from technically supporting these tasks to discussing and understanding how the technology and tasks interrelated. Here, the researcher became a boundary creature moving between the role of technical support and activity support to that of technical and activity designer. Within subsequent system iterations, the researcher utilised these different types of insights within the content management feedback and a parallel networking infrastructure that tried to support a steady flow of information exchange (see Figure 5).

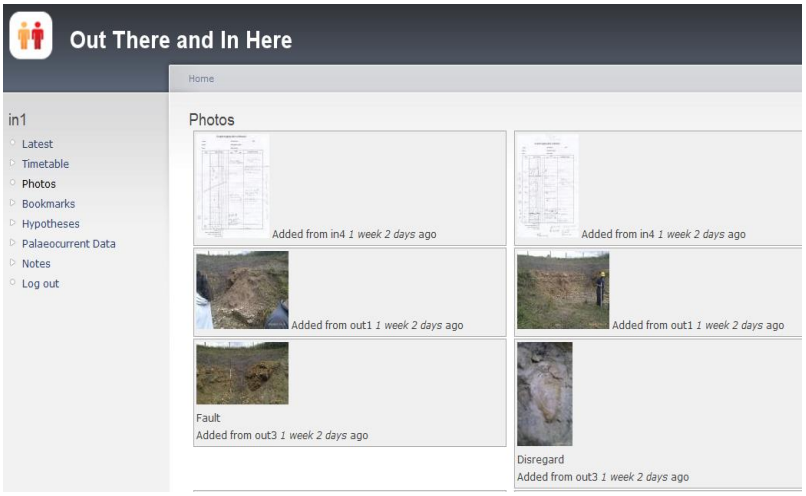

Fig. 5. OTIH content management system

Within the Hidden Histories project, again the researcher frequently jumped between technical support to evaluating and redesigning the system. The researchers found themselves supporting the participants when a location wouldn't trigger an event whilst also noting that participants found that the technology 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)

Whilst complex for the researcher, jumping between these different roles in the wild can provide serendipitous insight into not only the technologies but also the tasks themselves.

Finally 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 consider the needs of different community groups, user advocates, organisational and industrial investors' interests. It could be argued that research that aims primarily to innovate with 'catwalk technologies' can avoid many socio-political issues by aiming not to support sustainable change to practices or produce scalable 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. Although it may be more difficult for a researcher to manage expectations for a 'prêt-à-porter' approach, it can result in more value to a wider set of stakeholders giving far greater impact.

Both the OTIH and Mobile GIS projects were couched within sensitive political contexts with regard to geoscience field work and the learning process. Educational 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 technological or practice based developments within these contexts will be scrutinised closely by stakeholders. This sometimes caused tensions for the researchers within these projects, as they were encouraged to turn innovation into scalable and 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.

Researchers within the Mobile GIS project acted as boundary creatures to alleviate this tension by feeding research directly into the formal learning process for the geography department that offered the field trip module. The OTIH research team dealt with these tensions by developing 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, can be complex and requires careful management.

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. However, 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' contexts. 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 Boundary Objects: Catwalk and Prêt-à-Porter design

As already highlighted within all three projects, the technologies acted as boundary objects supporting and translating collaboration practices between different sites, student interpretations and public engagement of information linked to different geographic and historic physical locations. However, within each of the case studies there were different assumptions and expectations about the role of innovation and scalable designs.

The OTIH project actively sought to innovate with the technology whilst allowing for some approaches to be developed into scalable educational methods. In particular the researchers sought

to develop in the wild, flexible systems that supported situated learning both in the field and through collaboration across and between different locations.

For the OTIH students, participants' acceptability of the system was driven by expectations and a need for scalable and sustainable boundary objects. For example, the phone applications were noted as providing poor collaborative support because of the small display size of images for all types and ages of users when capturing and sharing with others at the same location. In comparison, a larger sized tablet was noted by students in the field as a 'real' solution for the presentation of information to the co-located group, despite it being more burdensome to carry (see Figure 7). The tablets were seen as effective scalable solutions. Trial feedback focused on costs and the timescales for course materials and related applications to be available. These points highlighted the students' eagerness to acquire scalable and sustainable solutions for their field works activities. Whilst the role of mobile technologies for field based education is not innovative, the ecology of these technologies to support distributed 'live' collaborative learning is novel. 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 those practices 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)

Fig. 7. Personal smartphone usage compared to sharing through the tablet

However, as already noted, the students were continually driven by expectations that the research would support systems that could be implemented and support their current practices. On-going discussions and re-designs continually returned to the question of scalability.

In contrast, innovation via boundary objects that initiated a change in practices produced spatial implications for deploying the system in the wild. Participants in the laboratory found it difficult to spatially locate and translate the information they had received from others in the field. The research team sought to counteract these issues by geo-referencing the data from the field location, so that those out of context in the laboratory could locate the incoming data on the map and build a 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 participants to locate, for example, whether one fossil was found in relation to another, thus altering the effectiveness of the technology to support the related task. 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)

Currently the potential to scale and sustain personal devices for distributed formal learning between situated groups is not currently achievable. However, the research highlighted elements of this innovation that could be pursued as scalable. For example, it could be that the success of

the tablet device as a social boundary object that enables translation between users in the field, lies in its similarity to the clipboard traditionally used for sharing field information. This subsequently facilitates current learning practices when using novel boundary objects making the move to prêt-à-porter scalability easier.

For the Mobile GIS project, the move from a variety of innovative technologies to a scalable and sustainable system was crucial, as it would provide a cost-effective approach to field work providing the skills and competencies that cannot be obtained in other contexts. In particular, the participants noted how powerful the innovative spatial approach was as a boundary object practice, for translating understanding in a geoscience learning task regardless of the technology used:

"the acetate was actually so effective, because …[ ] 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)

The transparent nature of the acetate (shown in Figure 8) emphasises the visual richness of the landscape by simplifying the annotation layer, meaning that participants can easily relate the two together, effortlessly switching focus between the information layer and the landscape scene. This then enables the acetate to become an effective boundary object helping users make associations between information and the landscape scene.

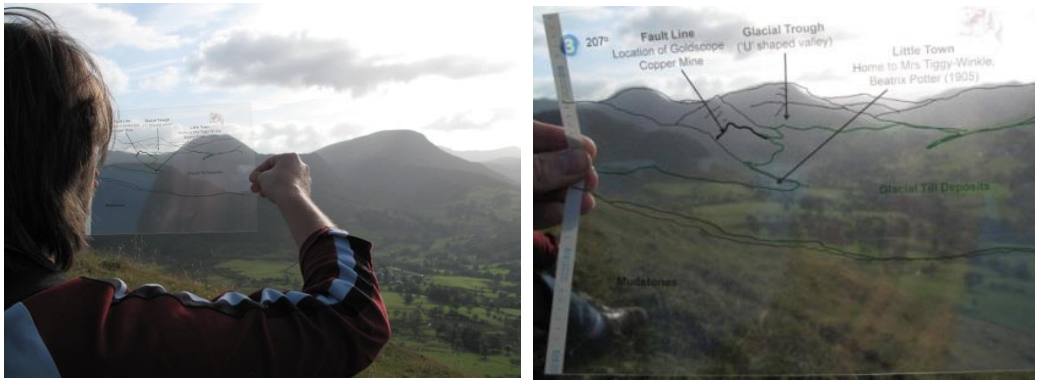

Fig. 8. Acetates being used in the field, including a first-person perspective on the right.

As more technically advanced approaches were introduced various forms of disconnect between media and the landscape scene were observed and often a preoccupation with the electronic media and device occurred. Ultimately, the electronic media was failing as a boundary object. The participants became enthralled by the object rather than allowing it to support their translations between the information and landscape contexts. On occasions participants had undue faith in some of the sophisticated delivery of the media, for example the ability of GeoMole to trigger audio according to the features that should be visible from a certain point. For example, participants were observed looking down into one valley whilst listening to a description of the landscape history of the valley behind them.

The development and maintenance of the more innovative technologies was expensive and required a great deal of support to deploy them on field exercises. Inevitably such technologies had to be distributed across quite large groups, so making it difficult for individuals to have hands-on experience of each technique. This became a tension, managed only by groups sharing experiences and working together to solve issues as they surfaced. The necessary financial inputs and staff support for future field exercises could not be guaranteed, thus necessitating more sustainable approaches, which could be scaled to provide better technology access. This had to be balanced by the desire to maintain focus on the research challenges and learning objectives associated with augmenting landscape scenes in ways which are meaningful to users 'in the wild'. The commercial proliferation of smartphones during this period offered a way to achieve these goals whilst preserving some degree of technical innovation.

The design for on-going and future research-led field exercises has therefore attempted to identify key affordances of the various technologies employed to date. The simplicity of the acetate and its ability to maintain focus on the design of the information layer was important. The basic locative media function of GeoMole and Mscape allowed exploration of the situational relevance of media but other capabilities of these approaches distracted and their unfamiliarity to

many participants rendered the devices ineffective as boundary objects. The orientation-specific augmentation of the HMD was desirable, but without the technical overheads.

The transition towards a more sustainable approach has adopted smartphone-based AR browsers and subsequently the 'Zapp' application. In addition to this, a simple locative media implementation allows digital acetates to be used to explore graphical portrayals. There will also be a conscious effort to connect the studies with ongoing research challenges facing AR browsers and Location-Based Service applications in terms of their effectiveness in providing the user with relevant context-specific information.

Within the Hidden Histories and Mobile GIS projects, the social space itself had an important impact on the scalability of the boundary object design. 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. These concerns impacted on the potential for scalability of these boundary object practices. 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. Again this highlights issues with designing the boundary object practices around in the wild contexts. 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 participants 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 as boundary objects:

"*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. Through this explanation it was hoped that the participants' expectations of the boundary object would be framed around it being an innovative yet prototype translation device.

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 that the participants were continually expecting these developments to be prêt-à-porter rather than catwalk technologies. However, this suggests that there is further research to be completed around how to guide participants' expectations towards the assumed research scalability or sustainability of these technologies as boundary objects.

Ultimately this section highlights the need to design boundary objects as translations between spaces, communities and users. To do this we must consider the boundary object practices not only within social and physical context but within that of the expectations of the stakeholders and participants. Expectations of a boundary object as a stand-alone innovation or a scalable resource can frame participants' interactions and designers' development practices. We argue that, in future projects, there is a need to articulate to researchers, stakeholders and research participants', the assumptions about the expected scalability and sustainability of boundary objects and related practices.

5. DISCUSSION

The research findings revealed design process tensions within each case-study. Research goals to innovate and change practices (developing catwalk technologies) were often at odds with stakeholders' expectations for prêt-à-porter scalable and sustainable systems that supported current practices. The researcher often had to manage these tensions along with the practicalities of implementing and redesigning systems in the wild to meet the research goals. To achieve this, the researcher as a boundary creature had to jump between many different roles:

- Supporting change: supporting technology usage and changes in participants practice.
- Developing systems: adapting technology and tasks to fit changing situational and social norm needs.
- Understanding systems: documenting and interpreting the users, technology and interactions in-situ.
- Managing tensions: managing stakeholders and participants expectations for the research at odds with research goals.

As highlighted by Rogers [2011], in the wild design processes seek to create and evaluate new technologies in-situ, rather than observing existing practices and then make design recommendations or develop system requirements. When developing systems 'on the fly' in the wild, the concept of a 'boundary creature' becomes an invaluable linchpin. It is down to the researcher to cross between the multiple roles and communities that exist in the wild. A researcher must adapt their role, as Johnson et al. [2012] suggests, from supporting the participant in their changing practices (supporting change) with the novel technology whilst also capturing changes to design decisions (developing systems) and understand interactions (understanding systems). However, when placed within complex in the wild contexts the researcher must also adapt their support and design decisions to the conventions and needs of that wild context (managing tensions).

One way to support the movement between the different roles of boundary creatures is to take a more reflexive approach to research in the wild. As a boundary creature supporting change and developing systems in the wild, researchers must remain aware and be sensitive to spatial issues and tensions that can occur in the research process. Within the case studies presented in this paper, we have identified that these issues spread from the quite simplistic concerns of managing technology in different weather conditions, to complex safety issues as participants 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, that there was a different flow of time in the laboratory to that within the wild, an observation that was also noted by Marshal at al. [2011] in relation to changing spatial

acuity when comparing the two environments. The researchers in our studies identified how participants felt this change impacted negatively on their engagement with the activities and the acceptability of the technologies. In some cases, however, the researchers developed a temporal acuity and adapted the design of the activities and the technologies to allow the participants 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 they were engaged in. This reflexive approach to the whole experience then provides a link between developing a system and supporting change. 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; this work also relates strongly to the 'cultural probes' research by Gaver et al. that we have mentioned in section 2.1. However, the role of the researcher in facilitating this transformational change is not discussed. Jordan [2010] reviews how the related concept of affinity in design also relates to concepts of identity and the self. In particular, his 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 these personal transformations. However, we would argue that this depends upon how reflexive they are upon their own processes and how responsive they are to these reflections.

Practitioner inquiry supports the researcher in taking a reflexive approach to their research and adapting the research according to those reflections. However, one of the key issues in moving forward in reflexive manner is the researchers' ability to manage stakeholder tensions in expectations in the design process. 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 social, political and economic contexts. 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 participants' comments frequently turned to the cost of devices or applications and the potential to be robbed for their 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. The researchers could have ignored these tensions as they did not fit with the original research questions and objectives. However, through a post-reflexive approach each project revealed the need for researchers to deal with stakeholder tensions in the 'wild' design process. Participants felt self-conscious wearing fairly obvious head-mounted displays or concerned for their safety carrying expensive technology in public situations. 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 earlier reflections and a reflexive account from the different parties' around their design in the wild expectations may have been a useful tool to identify these issues. The design cycle for practitioner inquiry has built into the process these reflection points. Figure 10 presents this translated into the HCI / computing design cycle terminology.

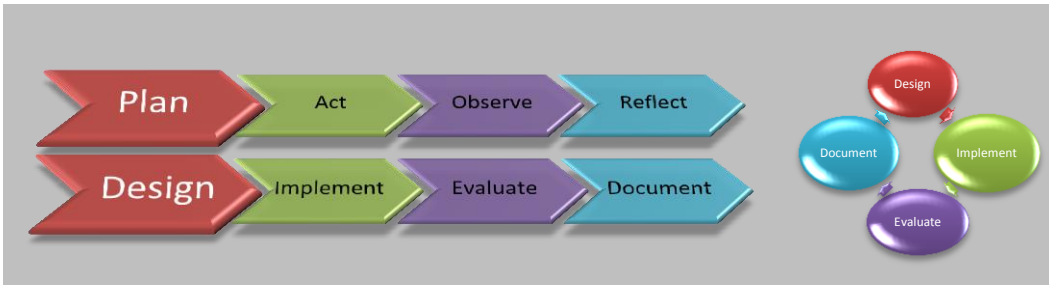

Fig. 10. Practitioner inquiry cycle mapped onto HCI research cycle [adapted from Reason and Brandbury 2001]

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. A further exploration of the concept of catwalk technologies and prêt-à-porter design processes can support reflections around tensions in expectations.

5.1 Catwalk and Prêt-à-Porter Design Processes

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 for mapping expectations that can guide stakeholders' expectations and thus the researcher design role (RDR) in the research and design process. Researchers within the case studies found that even a post-hoc reflexive account using the RDR model to review how they had interacted with stakeholders within the design, deployment and evaluation processes provided a mechanism to manage their boundary creature roles 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 RDR reveals that there is a continuum of two primary tensions researchers manage as a boundary creature for in-the-wild research. Firstly, stakeholders' expectations of the technology design and deployment process being led by either innovation or scalable and sustainable solutions. Secondly, expectations that the project, technologies and tasks are seeking to maintain or change current practices. Understanding these expectations can alter perceptions of stakeholders as they could perceive the system as 'changing practices' to those that are unworkable or possibly empowering. In contrast, participants 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. A focus on innovation could be thought of as inspiring new possibilities or just simply a waste of time and money. Key for the researcher is to map out with the research team where the project sits within the RDR and any movement that they see occurring over the lifetime of the project. As a boundary creature they must also seek to support stakeholders' appropriate expectations for the researcher, and the research.

Within each of our case studies the researchers noted that the research team had different starting expectations for each project. This resulted in different types of researcher design roles (RDR) that they sought to undertake in their research. Both the Mobile GIS and the OTIH project sought to innovate with the use of technology and tasks. They also sought to change current geoscience practices and how they used technology in those practices. These initial expectations

for each project can be seen in Figure 11. For example, the Mobile GIS project used virtual and augmented realities for field trip activities to change how geographers interpreted and understood their field trip environment whilst in that context. The OTIH project used an ecology of information systems, recording and communication devices across different locations to support a change in geologists' inquiry practices to support 'live' distributed and collaborative reflection. In contrast, the Hidden Histories project utilised some systems that changed public practices (part of the expectation influence seen in Figure 11). However, the main thrust of the project aimed to make current systems and history learning in the field, more effective by introducing mobile systems that are far closer to becoming scalable and sustainable than the systems in the other projects. The expectation behind the HH project was never to totally innovate the technology for *in situ* history learning, 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 activities that took place.

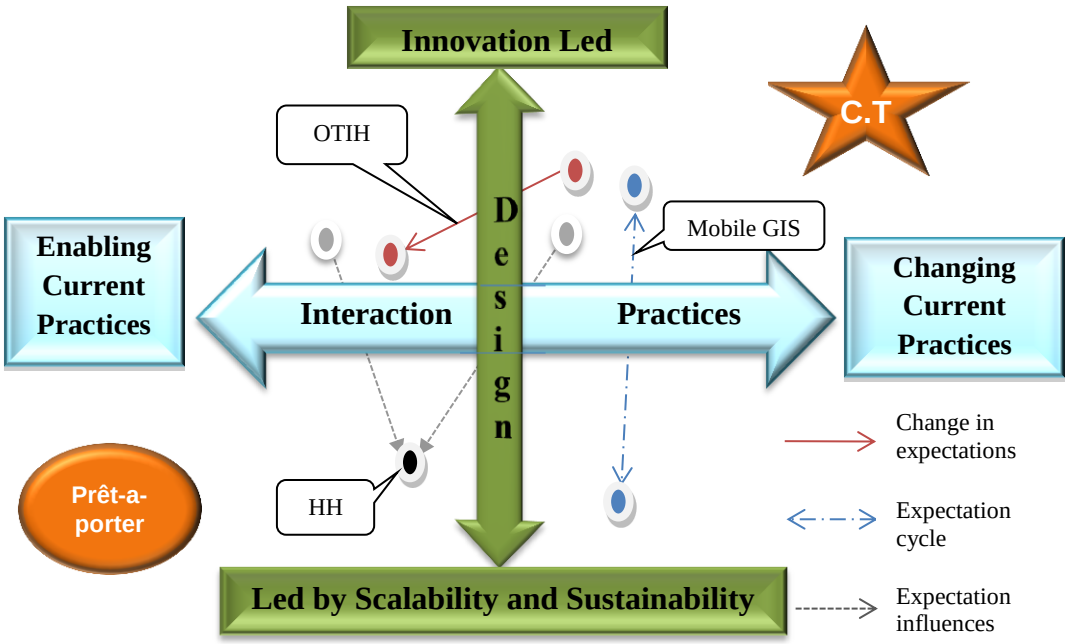

Fig. 11. Researcher design roles: mapping expectations from catwalk technologies (CT) to prêt-à-porter designs

The participants and stakeholders in the Mobile GIS and OTIH projects realised that their 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 moving towards scalable mobile applications (such as Zapp, mentioned in section 3.2.2) which strove for the simplicity of the computer-generated acetate technique whilst maintaining some of the innovation of the head-mounted display. This cycle for the Mobile GIS project is represented in Figure 11 as an expectation cycle. The OTIH developments initially focused on changing practices and later in redesigns on 'enabling current practices', enhancing links into more scalable and sustainable systems. Again this is represented in Figure 11 as a change in expectations for the OTIH project. Whilst, for OTIH, the economic climate has changed institutional responses to the likelihood of these systems being scalable, there continues to be developments based on understandings produced from these insights.

The RDR model also highlights the position of catwalk technologies and prêt-à-porter in the design and deployment process. The concept of in-the-wild research changing and even sometimes disrupting current practices fits strongly with our metaphor of a catwalk technology (CT). A catwalk design, like art, often seeks to change our concepts of an object and also how we interact with it. Catwalk fashions actively seek both to innovate in the materials used and in how they are

used by the models. They also seek to change our practices with what we wear (i.e. what is a dress). 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. A shoe, for example, is not just functional but it is also aesthetic. The style and design change how we feel about the shoe. A suede Jimmy Choo shoe can change how someone perceives themselves or is perceived by others, making a social statement or fitting with social norms. However, sometimes innovations in the style, materials used and its construction can change how we use the shoe. Adding wheels to a leather trainer changes it into a plaything, adding a steel toe-cap will make it safer to use on a building site, compartments can change its functionality into that of a secure and easy-to-carry wallet. A catwalk design may not be scalable or even work as a design for everyday usage (i.e. work as an everyday shoe). However, they have often inspired a change in practices or carried over to prêt-à-porter designs that have enhanced current practices.

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 full functionality (even if it appears to do so, aka the '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 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 sit. Through usability evaluations, we seek to establish hooks into how to make systems 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 as nearer that of a prêt-à-porter system. 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. 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. Although further research is required to expand and verify the RDR model, of key interest is the move from a catwalk technology to a scalable and sustainable system that changes current practices. It could be argued that some of our greatest technological developments have taken this path.

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, rapid technology and design changes necessitate that, for HCI researchers to become insightful brokers, we must develop reflexive approaches to our work and how we see ourselves [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, through our creative designs and reflections, we can cross established boundaries. We can become explorers and through boundary crossing, bring home to HCI 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 a boundary creature. This means not only within regard to the participants or other stakeholders but within the

[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.

socio-political standing of the research. This requires an understanding of our expectations and those of stakeholders for our research in the design process. Reflections upon designs as a catwalk technology or a prêt-à-porter (ready to wear) system and movements between these two can help us in agreed expectations. The researcher design role (RDR) model can help in supporting those agreed reflections and expectations. However, whilst it is important to understand the design process and our role in this we must also understand our research within the context of the institutions we belong, the funders who sponsor the research and the policy makers who instantiate the research. In appreciating the role of innovation in design and when appropriate the move towards scalable and sustainable designs, we can proudly take on the role of boundary creature transforming through catwalk technologies or prêt-à-porter systems. To do this however, we have to take on the mantle of being considered as both horrific and empowering.

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REFERENCES

ADAMS, A. 2013. Situated eLearning: empowerment and barriers to identity changes. In *Digital Identity and Social Media* S. WARBURTON AND S. HATZIPANAGOS Eds. IGI Global Publishers, UK.

ADAMS, A., BLANDFORD, A. AND LUNT, P. 2005. Social empowerment and exclusion: A case study on digital libraries. *ACM Transactions on Computer-Human Interaction 12*, 174-200.

ADAMS, A., CAIRNS, P. AND LUNT, P. 2008. A qualitative approach to HCI research. In *Research Methods for Human Computer Interaction*, P.A. CAIRNS AND A.L. COX Eds. Cambridge University Press, Cambridge, UK, 138-157.

ALVESSON, M. AND WILLMOTT, H. 2002. Identity regulation as organizational control: producing the appropriate individual. *Journal of Management Studies 39*, 619-644.

ATKINSON, P. AND HAMMERSLEY, M. 1994. Ethnography and participant observation. In *Handbook of Qualitative Research*, N.K. DENZIN AND Y.S. LINCOLN Eds. Sage Publications, Thousand Oaks, 248-261.

AVERY, B., SMITH, R.T., PIEKARSKI, W. AND THOMAS, B. 2010. Designing Outdoor Mixed Reality Hardware Systems. In *The Engineering of Mixed Reality Systems*, E. DUBOIS, P. GRAY AND L. NIGAY Eds. Human-Computer Interaction Series, Springer-Verlag.

BECKETT, D. AND MORRIS, G. 2001. Ontological performance: Bodies, identities and learning. *Studies in the Education of Adults 33*, 35-48.

BECVAR, A., HOLLAN, J. AND HUTCHINS, E. 2008. Representational gestures as cognitive artifacts for developing theories in a scientific laboratory. In *Proceedings of the 2008 ACM Conference on Computer Supported Cooperative Work*, San Diego, CA, USA, November 08-12, 2008, ACM, New York, NY, USA, 117-143.

BENFORD, S., GIANNACHI, G., KOLEVA, B. AND RODDEN, T. 2009. From Interaction to Trajectories: Designing Coherent Journeys Through User Experiences. In *Proceedings of the 27th International Conference Conference on Human Factors in Computing Systems*, Boston, MA, USA, April 04-09, 2009, ACM, New York, NY, USA, 709-718.

BERNSTEIN, B. AND SOLOMON, J. 1999. 'Pedagogy, Identity and the Construction of a Theory of Symbolic Control': Basil Bernstein questioned by Joseph Solomon. *British Journal of Sociology of Education 20*, 265-279.

BLEVIS, E. 2007. Sustainable interaction design: invention & disposal, renewal & reuse. In *Proceedings of the SIGCHI conference on Human factors in computing systems* San Jose, California, USA, 28 April-3 May, 2007, ACM, New York, NY, USA, 503-512.

BØDKER, S. 2006. When second wave HCI meets third wave challenges. In *Proceedings of the 4th Nordic Conference on Human-Computer Interaction (NordiCHI '06)*, Oslo, Norway, 14-18 October 2006, 1-8.

BOWKER, G.C. AND STAR, S.L. 2000. *Sorting Things Out: Classification and Its Consequences*. MIT Press, Cambridge, MA.

BRYANT, S.L., FORTE, A. AND BRUCKMAN, A. 2005. Becoming Wikipedian: Transformation of participation in a collaborative online encyclopedia. In *Proceedings of the 2005 International ACM SIGGROUP Conference on Supporting Group Work (GROUP '05)*, Sanibel Island, Florida, USA, November 6–9, 2005, ACM, New York, NY, USA, 1-10.

BRYDON-MILLER, M. AND MAGUIRE, P. 2009. Participatory action research: contributions to the development of practitioner inquiry in education. *Educational Action Research 17*, 79-93.

BURNS, C., COTTAM, H., VANSTONE, C. AND WINHALL, J. 2006 RED paper 02: transformational design. Available at http://www.designcouncil.info/RED/transformationdesign/REDPAPER02TransformationDesign.pdf [accessed 17/07/12].

BURT, R.S. 2005. *Brokerage and Closure: An Introduction to Social Capital*. Oxford University Press, Oxford.

CARR, W. AND KEMMIS, S. 1986. *Becoming critical: education, knowledge and action research*. Falmer, London.

CSIKSZENTMIHALYI, M. 1990. *Flow: The Psychology of Optimal Experience*. Harper and Row, New York.

CUNNINGHAM, S.J. AND JONES, M. 2005. Autoethnography: A tool for practice and education. In *Proceedings of the 6th ACM SIGCHI New Zealand Chapter's International Conference on Computer-Human Interaction (CHINZ '05)*, Auckland, New Zealand, July 7-8, 2005, ACM, New York, NY, USA, 1-8.

CUNNINGHAM, S.J., MASOODIAN, M. AND ADAMS, A. 2010. Privacy issues for online personal photograph collections. *Journal of Theoretical and Applied Electronic Commerce Research 5*, 26-40.

DESIGN COUNCIL 2011 Design for innovation. Available at http://www.designcouncil.org.uk/documents/documents/ourwork/insight/designforinnovation/designforinnovation_dec2011.pdf [accessed 16/07/12].

DRENNON, C. 2002. Negotiated Power and Politics in Practitioner Inquiry Communities. *New Directions for Adult and Continuing Education*, 61-71.

FERRERO-REGIS, T. 2010. Reframing fashion: from original and copy to adaptation. In *Proceedings of the 2nd Global Conference, Fashion: Exploring Critical Issues*, Oxford, UK, September 23-26, 2010.

FITZGERALD, E., TAYLOR, C. AND CRAVEN, M. 2012. To the Castle! A comparison of two audio guides to enable public discovery of historical events. *Personal and Ubiquitous Computing*, 1-12.

GAVED, M., MULHOLLAND, P., KERAWALLA, L., COLLINS, T. AND SCANLON, E. 2010. More notspots than hotspots: strategies for undertaking networked learning in the real world. In *Proceedings of the 9th World Conference on Mobile and Contextual Learning (mLearn2010)*, Valetta, Malta, October 19-22, 2010, 1-4.

GAVER, B., DUNNE, T. AND PACENTI, E. 1999. Design: Cultural probes. *Interactions 6*, 21-29.

GAVER, W., BOUCHER, A., PENNINGTON, S. AND WALKER, B. 2004. Cultural probes and the value of uncertainty. *Interactions 11*, 53-56.

GIDDENS, A. 1984. *The constitution of society*. Polity Press, Cambridge.

GOFFMAN, E. 1969. *The presentation of self in everyday life*. Penguin Press, London.

GUILE, D. 2006. Access learning and development in the creative and cultural sectors: From 'creative apprenticeship' to 'being apprenticed'. *Journal of Education and Work 19*, 433–453.

HARAWAY, D. 1991. *Simians, Cyborgs and Women: the reinvention of nature*. Free Association Books, London.

HENWOOD, K.L. AND PIDGEON, N.F. 1992. Qualitative research and psychological theorising. *British Journal of Psychology 83*, 97-111.

HUTCHINS, E. 1995. *Cognition in the wild*. MIT Press, Cambridge, MA.

HUTCHINSON, H., MACKAY, W., WESTERLUND, B., BEDERSON, B.B., DRUIN, A., PLAISANT, C., BEAUDOUIN-LAFON, M., CONVERSY, S., EVANS, H., HANSEN, H., ROUSSEL, N. AND EIDERBÄCK, B. 2003. Technology probes: inspiring design for and with families. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '03)*, Ft. Lauderdale, Florida, USA ACM, New York, NY, USA, 17-24.

JARVIS, C., PRIESTNALL, G., POLMEAR, G. AND LI., J. 2008. Geo-contextualised visualisation for teaching and learning in the field. In *Proceedings of the 2008 Geographical Information Science Research UK (GISRUK) Conference*, Manchester Metropolitan University.

JOHNSON, R., ROGERS, Y., VAN DER LINDEN, J. AND BIANCHI-BERTHOUZE, N. 2012. Being in the thick of in-the-wild studies: the challenges and insights of researcher participation. In *Proceedings of the 2012 ACM Annual Conference on Human Factors in Computing Systems (CHI '12)*, Austin, Texas, USA, May 05-10, 2012, ACM, New York, NY, USA, 1135-1144.

JONES, G., MCLEAN, C. AND QUATTRONE, P. 2004. Spacing and timing. *Organization 11*, 723-741.

JORDAN, M. 2010. The meaning of affinity and the importance fo identity in the designed world. *Interactions 17*, 6-11.

LAVE, J. AND WENGER, E. 1991. *Situated Learning - Legitimate Peripheral Participation*. Cambridge University Press, Cambridge.

LUCKIN, R. 2008. The learner centric ecology of resources: a framework for using technology to scaffold learning. *Computers & Education 50*, 449-462.

MARSHALL, P., MORRIS, R., ROGERS, Y., KREITMAYER, S. AND DAVIES, M. 2011. Rethinking 'multi-user': An in-the-wild study of how groups approach a walk-up-and-use tabletop interface. In *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems*, Vancouver, BC, Canada, May 7-12, 2011, ACM, New York, NY, USA 3033-3042.

MCCARTHY, J. AND WRIGHT, P. 2004. *Technology as Experience*. MIT Press, Cambridge, MA.

MEEK, S., PRIESTNALL, G., SHARPLES, M. AND GOULDING, J. 2013. Remote Mobile Capture of Points of Interest Using Line of Sight Modelling. *Computers & GeoSciences 52, 334-344*.

MERRIAM, S.B. 1998. *Qualitative research and case study applications in education*. Jossey-Bass Publishers, San Francisco.

NARDI, B.A. AND O'DAY, V.L. 1999. *Information ecologies: using technology with heart*. MIT Press, Cambridge, MA.

NERB, J., RITTER, F. AND LANGLEY, P. 2007. Rules of Order: Process Models of Human Learning. In *In Order to Learn: How the Sequence of Topics Influences Learning (Oxford Series on Cognitive Models and Architectures)*, F. RITTER, J. NERB, E. LEHTINEN AND T. O'SHEA Eds. Oxford University Press, Oxford, 57-70.

NOOR, K.B.M. 2008. Case study: a strategic research methodology. *American Journal of Applied Sciences 5*, 1602-1604.

PATTON, M.Q. 2002. *Qualitative research & evaluation methods*. Sage Publications, London, UK.

PREECE, J. AND SCHNEIDERMAN, B. 2009. The Reader-to-Leader Framework: Motivating Technology-Mediated Social Participation. *AIS Transactions on Human Computer Interaction 1*, 13-32.

REASON, P. AND BRANDBURY, H. 2001. *Handbook of Action Research: Participative Inquiry and Practice*. Sage, London

ROGERS, Y. 2011. Interaction design gone wild: striving for wild theory. *Interactions 18*, 58-62.

SANDERS, T. AND CAIRNS, P. 2010. Time perception, immersion and music in videogames. In *Proceedings of the 24th BCS Interaction Specialist Group Conference (BCS '10)*, Dundee, United Kingdom, September 06-10, 2010, British Computer Society, Swinton, UK, 160-167.

SCHIPHORST, T. 2011. Self-evidence: applying somatic connoisseurship to experience design. In *Proceedings of the 2011 Annual Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '11)*, Vancouver, BC, Canada, May 07-12, 2011, ACM, New York, NY, USA, 145-160.

SHARPLES, M. 2000. The Design of Personal Mobile Technologies for Lifelong Learning. *Computers & Education 34*, 177-193.

STAKE, R.E. 2005. Qualitative case studies. In *The Sage Handbook of Qualitative Research*, N.K. DENZIN AND Y.S. LINCOLN Eds. Sage Publications, London.

STAR, S.L. AND GRIESEMER, J.R. 1989. Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science 19*, 387-420

STENTON, S.P., HULL, R., GODDI, P.M., REID, J.E., CLAYTON, B.J., MELAMED, T.J. AND WEE, S. 2007. Mediascapes: Context-Aware Multimedia Experiences. *IEEE Multimedia 14*, 98-105.

STEUER, J. 1992. Defining virtual reality: dimensions determining telepresence. *Journal of Communication 42*, 73-93.

STRAUSS, A.L. AND CORBIN, J.M. 1990. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Sage, Thousand Oaks.

SUCHMAN, L. 2011. Public lecture: Reconfiguring Agencies at the Interface: New Entanglements of Bodies and Machines.Available at http://www.arts.manchester.ac.uk/cidra/events/publiclectureseriesinteriors/lucysuchman/.

WILLIG, C. 2001. *Introducing Qualitative Research in Psychology: Adventures in Theory and Method*. Open University Press, Buckingham.

WOLF, T.V., RODE, J.A., SUSSMAN, J. AND KELLOGG, W.A. 2006. Dispelling "design" as the black art of CHI. In *Proceedings of the SIGCHI conference on Human Factors in Computing Systems (CHI '06)*, Montréal, Canada, April 22-27, 2006, ACM, New York, NY, USA, 521-530.

WRIGHT, P., WALLACE, J. AND MCCARTHY, J. 2008. Aesthetics and experience-centred design. *ACM Transactions on Computer-Human Interaction 15*, 1-21.