Technomethodology *

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Harold Garfinkel has had occasion to note that "ethnomethodology *is* applied ethnomethodology" and that in its application it has ambitions to become a "hybrid discipline", merging with different professions to address their occupational troubles. This paper discusses the emergence of one such hybrid discipline – technomethodology - in Information Technology (IT) research. Ethnomethodology has been involved in IT research for twenty years, where the approach initially helped the designers of IT systems address the troubles brought about by the mismatch of computer applications with the real world, real time circumstances of their use. In this respect, ethnomethodology's original role in IT research was a critical one, drawing attention to the failings of psychological models on which design was predicated, and the need for design to be responsive to the social circumstances of work within which IT systems are embedded in their use. This early involvement resulted in the 'turn to the social' in IT research, where the challenge became one of understanding the collaborative character of work. This, in turn, raised the challenge for ethnomethodology to move from design critique to design practice.

The move from design critique to design practice is a methodological move that requires ethnomethodology to become an active participant in the invention of the future. In the first instance, this resulted in the incorporation of 'workplace studies' in traditional product development processes. This is a problematic relationship, however, as it casts ethnomethodology in a service provider role that inhibits the development of a foundational hybrid relationship. The situation is compounded by the curious fact that the vast majority of ethnomethodological studies of work are not carried out in product development settings but in universities and commercial laboratories, where emphasis is placed on innovation rather than on the construction of products. There is a need, then, to reconfigure the relationship to allow the emergence of a socio-technical methodology – technomethodology - where technology becomes a vehicle for social research, the results of which in turn propel innovation and the invention of the future. Drawing on interdisciplinary work involved in the development of an internationally acclaimed mixed reality game, this paper articulates what technomethodology might be about, what it might look like, and what it might consist of concretely as a hybrid research methodology for IT research.

Keywords: Ethnomethodology, IT Research, Hybrid Discipline, Technomethodology.

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Introduction

In later years ethnomethodology's founder, Harold Garfinkel, outlined a radical ambition for the discipline that would, if broadly adopted, have a transformative effect on the practice of sociology and the social sciences more generally. This ambition was articulated under the auspices of the 'hybrid studies of work' label (Garfinkel unpub. manu. #1, Garfinkel 2001). It draws a distinction between the 'studies of work' programme (Garfinkel 1986) developed by ethnomethodology for the study of social organization and a more radical project that would result in the assimilation of ethnomethodology into a veritable host of occupations and professions. The radical character of this later project is summed up well by Mike Lynch.

> In his later writings, Garfinkel made suggestions for hybridizing ethnomethodology with other disciplines (mathematics, natural sciences, legal studies, etc.), so that the "product" of the research would not take the form of reports about exotic practices; instead it would consist of efforts to develop hybrid disciplines in which ethnomethodological studies of, for example, lawyer's work would contribute to legal research. Had this program taken seed throughout sociology, its effects would have been to disperse the "home" discipline into innumerable hybrids initially held together by the familiar themes that mark ethnomethodology's recognisable discourse. Because Garfinkel's variant of ethnomethodology eschews the specification of core methods and theoretical concepts, the effect would have been to dissolve any semblance of a foundation in the academic social sciences. Contrary to Heritage's summary, such a program could not establish a "natural observational base" for a science of occupations because that "base" would dissolve into a veritable ecology of local conspiracies that organizes and distributes the work of the various disciplines studied. (Lynch 1994)

The hybrid program has not had a broad impact on social science practice to date. It has, however, been of some utility in the field of Information Technology (IT) and this paper seeks to address one of the "local conspiracies" to emerge from interdisciplinary work between computer scientists and ethnomethodologists: *technomethodology*.

The notion of technomethodology was coined by Graham Button and Paul Dourish (1996) to describe a situation in which,

> rather than have systems design and ethnomethodology 'reach' towards each other and 'meet' at a design, we instead look to forge more foundational relationships, and then approach design from a new position.

The approach emerged from ethnomethodology's long-term involvement with IT research and systems design. Ethnomethodology's initial involvement in this area revolved around the mismatch between computer applications and the real world, real time circumstances of their use. In this respect, ethnomethodology's initial purchase was a critical one, drawing attention to the failings of psychological models on which design was predicated, and the need for design to be responsive to the social circumstances of work within which IT systems are embedded in their use (Suchman 1987). A corpus of critical studies of work, interaction and technology-in-use (Button 1992) followed Suchman's pioneering research (e.g. Heath and Luff 1991, Hughes et al. 1993, Bowers et al. 1995). Labelled 'ethnographic studies' and, latterly, 'workplace studies' (Luff et al. 2000), in a design context this corpus played both a significant role in shaping the 'turn to the social' in IT research and in the commensurate development of a new field of interdisciplinary inquiry: Computer Supported Cooperative Work (CSCW).

CSCW was, and is, a field of IT research and design dedicated to the development of computing technologies that are informed by, resonate with, and intervene in the social organization of situated action, and the development of CSCW systems raised a new challenge for ethnography generally (Grudin and Grinter 1995) and ethnomethodology in particular (Button and Dourish 1996). Simply put, the challenge was one of moving ethnomethodolgy from design critique to design practice and of actively involving the discipline in the "invention of the future" (ibid.). In other words, the challenge was one of making ethnomethodology an active participant in the construction and development of IT systems. The challenge was initially responded to by configuring workplace studies to fit into product design processes (COMIC 1994). This configuration saw studies of work aligned with 'requirements analysis' – i.e., the identification of functional requirements for an IT system (what activities a system should support and how) - and evaluation where the impact of a new system on work practice is addressed (Sommerville and Sawyer 1997).

While proving highly successful in many respects, this configuration was not and is not without its problems. The configuration of what are often described by computer scientists as 'informal' methods (e.g. Madsen et al. 1993) with product design processes raises the problem of linking highly detailed studies of situated action with 'formal' design methods that underpin the production of abstract systems models (Calvey et al. 1997, Crabtree 2003). While it may be argued that this problem is a red herring – that formalizations must be made to work and in the *in vivo* course of that work the link is made (Garfinkel unpub. manu. #2) – of more significance here is the nature of this configuration of the ethnomethodology-design relationship. Embedding studies of work in product development processes configures ethnomethodology in a service provider role that has "no strategic value" (Sharrock 2000). In other words, this kind of configuration at best sees ethnomethodology 'reaching out to meet at a design', rather than developing a foundational relationship *with* design. Product development processes inhibit the development of a hybrid discipline then.

Despite the alignment of ethnomethodology with product development processes it remains a curious fact that the vast majority of studies of work are not conducted in product development settings, but in academic and commercial research laboratories. In this context the development of a product is not the primary orientation of work. Rather, emphasis is placed on exploring the potential of new and emerging technologies or, to put it another way, on innovation and with that the invention of the future. While systems are developed in such settings they are typically unstable and prototypical in character and offer instantiations and explorations of underlying research concepts, rather than finished products that are ready for market. It is in this context that an alternate configuration of the ethnomethodology-design relationship has emerged, however, one which seeks to establish

> [a] foundational relationship … in which design adopts the analytic mentality of ethnomethodology, and ethnomethodology dons the practical mantle of design. We look forward, through this approach, to what Garfinkel has often referred to as the emergence of a 'hybrid' discipline out of ethnomethodological studies of other disciplines. (Button and Dourish 1996)

Button and Dourish identified three ways in which ethnomethodology might assume a constructive role in IT research:

1. *Learning from ethnomethodologists.* This category refers to organization of the ethnomethodology-design relationship through the active involvement of an ethnomethodological researcher in the design process.

2. *Learning from ethnomethodological accounts.* This category refers to organization of the ethnomethodology-design relationship through use of ethnomethodological accounts, or written field reports and analyses of work.

3. *Learning from ethnomethodology.* This category refers to organization of the ethnomethodology-design relationship through the exploration of foundational ethnomethodological principles and insights.

Exploration of the third way in particular provided the strong possibility of the advent of a hybrid discipline: technomethodology.

While Button and Dourish explored the possibility of hybridisation by bringing ethnomethodological principles to bear on generalization and abstraction in design, unfortunately very little has been done to further technomethodology since. The aim here is to move beyond Button and Dourish's considered though nonetheless early reflections. A case study of ethnomethodology's purchase in the development of a mixed reality game is provided to articulate how technomethodology might be developed by operationalizing, exploiting and developing ethnomethodology's principles and practices. Of particular value to the development of a hybrid interdisciplinary research practice is the ethnomethodological policy of conducting breaching experiments (Garfinkel 1967), which may be used to inform, support and propel innovation in design and actively contributes to the invention of the future (Crabtree 2004).

Breaching Experiments

The ethnomethodological notion of breaching experiments has recently been employed in design context by Steve Mann (Mann et al. 2003) in his remarkable exploration of computer wearables and surveillance technologies. Mann stages *public performances* as a research method to explore the potential of new and emerging technologies. These performances are designed to create situations of uncertainty, bewilderment, anxiety and confusion in order to breach and so bring into question everyday structures of surveillance, governance, and control.

Figure 1. Reversing surveillance in department stores

Mann wants technology to empower users and he seeks to employ public performances as breaching experiments to make visible and so invert the power structure of networked surveillance. Mann's notion of a breaching experiment reflects a common reading of Garfinkel's work, where the breaching experiment is construed of as a research procedure that necessarily disrupts ordinary action in order that the sociological analyst might "detect some expectancies that lend commonplace scenes their familiar, life-as-usual character, and to relate these to the stable social structures of everyday activities" (Garfinkel 1967). It was no part of Garfinkel's program to use such experiments as political devices, but rather, to make the taken for granted ways in which "the structures of everyday life are ordinarily and routinely produced" visible and available to sociological reflection. "Making trouble" – or breaching everyday activities – was conceived of as one way in which the empirical study of social organization might proceed.

Staging public performances and treating them as breaching experiments provides an important opportunity to develop a hybrid research practice that forges a foundational relationship between ethnomethodology and design in the exploration and development of new and emerging technologies. Breaching experiments move new and emerging technologies out of the research lab and situate them through public performance 'in the wild' (Benford et al. 2002), where they may be confronted by a host of locally and socially organized contingencies that shape their use (Benford et al. 2004). This approach to research enables ethnomethodology, which places analytic emphasis on the situated and contingent nature of practical action and practical reasoning (Garfinkel 2001) to 'don the practical mantle of design'. At the same time, and reflexively, the approach encourages design to 'adopt the analytic mentality of ethnomethodology' and examine in detail the situated and contingent nature of technology use implicated in the local production and concerted accomplishment of public performances. Treating public performances as breaching experiments situates ethnomethodology in the practicalities of IT research and orients designers to the 'haecceities' – i.e. the thisses and that's, just whats and just hows - that are essential to the study of situated action (Garfinkel unpub. manu #3, Crabtree 2001). There is one important caveat, however.

When considering the nature of breaching experiments, the emphasis placed on disrupting everyday activities is overstated by both social scientists and IT researchers, and misleading if taken too literally. If we consider the breaching experiments reported by Garfinkel, for example, then it is clear that "bewilderment, consternation, and confusion … anxiety, shame, guilt, and indignation" are not essential features of the breaching experiment. While his students often reported these effects when carrying out breaching experiments, it is also clear that they were not *always* present on the occasions when the experiments were carried out. When medical students were asked to assess a "boorish candidate" at interview, for example, Garfinkel reports that 7 out of 28 subjects (25% of the experiment's population) did not realise they were the victims of a well-contrived deception until after the fact. Or again, when sociology students were asked to bargain for goods in shops, they reported that:

> they were enjoying the assignment [and that] they had learned to their 'surprise' that one could bargain in standard priced settings with some realistic chance of an advantageous outcome, and planned to do so in the future, particularly for costly merchandise.

Hardly an occasion defined by bewilderment, consternation, confusion, and the rest. What is being suggested then, is that disruption is not a *necessary* criterion of the breaching experiment, though it may be sufficient.

Instead of construing of breaching experiments in narrow terms of sufficiency, the absence of necessity provides grounds to acknowledge the broader scope of the breaching experiment, one which goes beyond the "making of trouble" yet nevertheless respects the *spirit* of the procedure as conceived of by Garfinkel:

> [Breaching experiments] are demonstrations, designed, in Herbert Spiegelberg's phrase, as 'aids to a sluggish imagination'. I have found that they produce reflections through which the strangeness of an obstinately familiar world can be detected.

For Garfinkel, breaching experiments are essentially 'aids to a sluggish imagination', whether that be the sociological imagination, or design imagination, or, in an interdisciplinary context, both.

Staging public performances may be considered as breaching experiments in this sense then: that they are aids to a sluggish imagination; that they stimulate the technological imagination by situating emerging technologies in the wild and thereby *provoke* (in the etymological sense of 'call forth') concrete insights into the social character of new and emerging technologies. Of particular concern, are participants' reactions to the novel situations created by the performance and the *ad hoc* practices devised on the fly to make the technology work 'here and now'. Construed of as a provocational rather than a disruptive procedure, breaching experiments have parallels with a design approach called provotyping, where technological innovations 'trigger' cooperative analysis of practice and elaborate innovative design spaces (Mogensen and Trigg 1992). Breaching experiments do not address established practices, however, as none exist prior to performance, but make visible the contingent ways in which technology use is organized by participants and the interactional practices providing for the accomplishment of the performance's work (Button and Harper 1996). Knowledge of these novel practices may, in turn, be employed to support innovation in design.

Can You See Me Now?

Can You See Me Now? (CYSMN) is an internationally acclaimed mobile mixed reality game (Prix Ars Electronica 2003), where runners situated in the physical streets of a city chase and catch online players (Flintham et al. 2003). CYSMN is a multi-disciplinary collaboration between the performing arts group Blast Theory and the Mixed Reality Laboratory. The game was first staged as a public event in Sheffield (UK) over one weekend in December 2001 as part of the BBC's groundbreaking event, Shooting Live Artists (BBC 2001).

The Technology

CYSMN allowed up to 10 online 'players' to log into the game on the Internet simultaneously and be chased through a virtual model of a circumscribed area of Sheffield by 4 'runners', professional performers, who were located on the actual city streets and interacted with the players via handheld computers. The runners' interface was delivered to them on a handheld computer from a server located in a nearby building over an 802.11b wireless local area network. A GPS receiver plugged into the serial port of the handheld computer registered the runner's position as they

moved through the streets and this was sent back to the server over the wireless network. Given the small screen size of the handheld computer, the runners' interface allowed them to zoom between a global view of the gameplay area (Figure 2) and a close-up local view centred on their current position. In either view, player's positions were indicated by their online names displayed in red text. Runner's positions were indicated by their online names in blue text. The runners could also see the latest text messages sent by players. The runners communicated with one another and support staff via walkie-talkies with earpieces and a head-mounted microphone. The runners' talk was also broadcast to the online players and the runners carried digital cameras so that they could take a picture of the physical location where each player was caught. These pictures appeared on an archive web site after the event (Archive 2001).

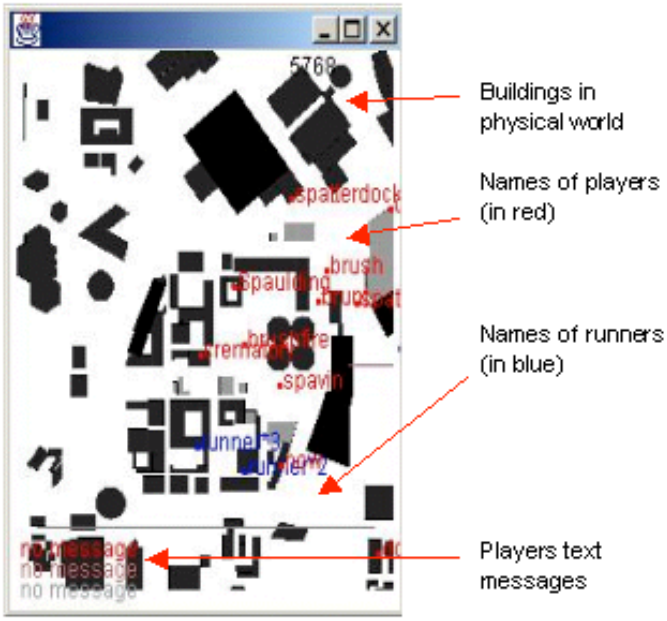

Figure 2. Runners' interface (global view)

Players had a local view of the gameplay area (Figure 3) and moved through a 2D virtual model of the city streets at a fixed maximum speed. A white player icon showed their current position according to their local client, providing immediate feedback as to their movement whenever they pressed a key. A blue icon showed their position according to the game server. This would trail behind the white icon with a lag of about one second due to the communication delay between client and server and the time taken to process players' movements at the server. Other players were represented as blue icons. Runners were shown as orange icons. Players communicated with one another and the runners via text messaging. When a runner got within 5 metres of a player, the player was caught, removed from the game, and offered a chance to re-enter the game queue.

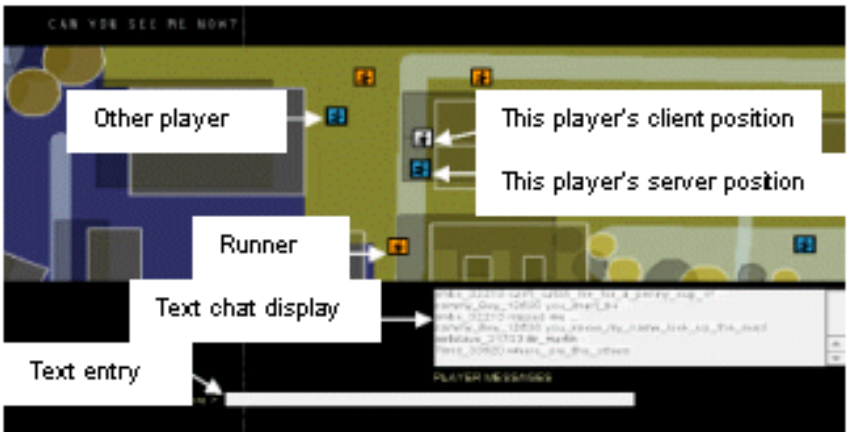

Figure 3. Online players' interface

While the technology was clearly designed to meet a use-purpose (playing a game), it is worth pointing out that the design was of a planful character. That is, it was designed to work according to a plan of use – that players would act in 'this' way, and runners 'that' way, and the technology would support projected forms of interaction. The technology was not designed for the actual circumstances whereby the plan (the game) was *realised* however (Suchman 1987), as those circumstances were not yet known. In the following section we elaborate the unknown by examining ethnographic vignettes of the technology-in-use. These vignettes are used to articulate the main findings to emerge from situating the technology in the wild and provoking practice.

Breaching Experiment #1. Sheffield

Previous attempts to migrate augmented reality outdoors have highlighted GPS inaccuracy as a primary research issue (Azuma 1999). While GPS is a versatile positioning technology for outdoor applications it can also be problematic, particularly with regard to inaccuracies that vary according to location on the Earth's surface, time of day, proximity to buildings, and weather. GPS accuracy ranges from a few centimetres up to tens of meters, and is often worse in urban environments and when using budget GPS receivers, both of which were significant factors in CYSMN.

Analysis of the system logs showed that from a technical perspective the GPS set-up employed in the game was highly inaccurate. Estimated errors ranged from 4 metres to 106 metres with a mean of 12.4 metres and a standard deviation of 5.8 metres. Error varied according to location in the game area, with some of the more open spaces typically exhibiting only a few metres error while the more narrow built up streets suffered considerably more. Consequently, the GPS situated runners in different locations on the map compared to their actual physical locations on the streets. They also resulted in the runners' avatars making sudden unfeasible jumps across the map. Such extreme errors were due to multi-path reflections or temporary losses of satellite visibility. Despite a wide variation of errors the runners still managed to capture players and to do so routinely without recourse for complaint or undue concern. GPS error was *not* a significant problem for the runners then, but how was this so?

```
Runner 1 (on walkie-talkie): I've taken a photograph of Sammy Boy.
Runner 1 (on walkie-talkie): The time is 7:16 pm.
Runner 1 puts the camera back in his bag and then looks at the handheld
interface.
Runner 1 (on walkie-talkie): Laughs  - 2 down!
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He changes his view on the handheld (from local to global) and looks to
see who is where on the map.
Runner 1 to other runners (on walkie-talkie): OK, I'm going to see if I
can come and help you with Jimbo (another player).
Runner 1 to other runners (on walkie-talkie): See if you can get above
Jimbo and drive him down towards the roundabout; I'll try and cut him of
at the roundabout.
```

Technically, location is furnished by GPS, which articulates the runner's geographical relation to one another and their virtual relation to online players. Interactionally, and as the above vignette shows us, locating runners and players consists in the doing of *locational work*. The vignette instructs us that locational work consists of the contingent conversational formulation of collaborative game-play strategies, within which the technology is embedded and used. The contingency of the matter revolves around who is playing the game and where they are. Thus, the runners might formulate the following collaborative strategy: "get above Jimbo and drive him towards the roundabout where I'll try to cut him off". Whatever the particular case, it was through the formulation of collaborative game-play strategies that the runners came to manage GPS inaccuracies and make use of an apparent deficiency in the technology to actually enhance gameplay:

```
Ethnographer: So your tactics: slow down, reel them in, and get them?
Runner: If they're in a place that I know it's really hard to catch them,
I walk around a little bit and wait till they're heading somewhere where I
can catch them.
Ethnographer: Ambush!
Runner: Yeah, ambush.
Ethnographer: What defines a good place to catch them?
Runner: A big open space, with good GPS coverage, where you can get quick
updates because then every move you make is updated when you're heading
towards them; because one of the problems is if you're running towards
them and you're in a place where it slowly updates, you jump past them,
and that's really frustrating.
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GPS accuracy was not construed of as a problem by the runners then but, through hands-on experience, as something to be exploited to inform the contingent formulation of collaborative gameplay strategies. In other words, the contingent formulation of gameplay strategies was directly informed by the runner' *working knowledge* of GPS accuracy. As the above vignette instructs us, that knowledge was used to inform decisions as to what 'what makes a good place to catch players' (and what doesn't) and what strategies it was therefore appropriate to formulate. Thus, and for example, trying to 'drive a player down towards the roundabout' was a good place to catch a player because there was a high level of GPS accuracy at that location.

Further examination of locational work also instructed us that the contingent formulation of collaborative game-play strategies relied on another distinct type of knowledge:

```
Runner 1 (on walkie-talkie): I need a runner at the glowing mushrooms! I
need a runner at the glowing mushrooms!
Runner 2 (on walkie-talkie): I'm thirty seconds away.
Runner 1 (on walkie-talkie): I need another runner to meet me at the
glowing mushroom.
Runner 2 (on walkie-talkie):  I'm ten seconds away.
Runner 1(on walkie-talkie): Where are you?
Runner 2 (on walkie-talkie): I'm going round to your right.
Runner 1looks to his right and sees Runner 2.
Runner 1 (on walkie-talkie): OK.
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Figure 4. The "glowing mushrooms" – two distinctive structures

This vignette shows us that the contingent formulation of collaborative game-play strategy also relied on *local knowledge of the physical environment* in which gameplay was situated. Like working knowledge of the technology, local knowledge of the environment was developed over the unfolding course of the game and exploited to coordinate the runner's actions in the accomplishment of locational work. Coordination relied on the runners' familiarity with the physical terrain features of the environment. Through experience, the runners came to know the location of structures that made up the built environment and became aware of the spatial relationship that buildings had with other structures (pavements, roads, walls, cul-de-sacs, etc.), together with the contours of the landscape (inclines, slopes, and hills). This knowledge was articulated in locally formulated names (e.g. 'the glowing mushrooms'), which provided *shared points of reference* in the physical terrain that the runners employed and oriented to, to coordinate their actions and track down players.

Local knowledge was essential to the runners' concerted efforts to 'make the technology work'. It was not that the two forms of knowledge – local knowledge of the environment and working knowledge of the technology – were separate phenomena, however. While distinctions may be drawn for analytic purposes (such as writing up reports), in practice the two were thoroughly intertwined and combined to form a *common stock of knowledge* (Schutz and Luckmann 1974) for playing the game. Observably, working knowledge of the technology (e.g. knowing 'where a good place to catch a player is') informed the formulation of collaborative game-play strategy in terms of local knowledge of the environment (e.g. 'drive him towards the roundabout' or 'meet me at the glowing mushrooms') and so it was through the combination of the two that the game came to be played in the real world.

It was a notable feature of gameplay, that the player's were unable to exploit the common stock of knowledge built up by the runners over the course of the game. The knowledge upon which gameplay relied was not reflected in the digital domain and so the players did not share the same 'picture' of the game as the runners. Consequently, players were often unaware that they were being targeted, they did not know and could not tell how far off the runners were until they emerged in their immediate sector, they could not tell which direction runners were approaching from, and consequently, players often failed to take evasive action until it was too late or

alternately, took evasive action when none was required. In short, players could not *assess and respond* to the current state of play: Just how many runners are chasing me? Where are they? What does their talk mean? These were relevant questions that player's could not ask let alone answer given their restricted view and the unavailability of the common stock of knowledge.

Breaching Experiment #2. Rotterdam

The phenomena seen in the breach – seen, that is, in the provocation of practice brought about by staging a public performance and confronting the technology with real world circumstances of use – provided concrete resources for thinking about innovation. Accordingly, the practices that the use of CYSMN 'turned upon' – the exploitation of a common stock of knowledge – informed the redesign of the players' interface. Buildings and topographical features were labelled to reflect the runners' local knowledge of the gameplay environment and to provide a shared frame of reference for all parties to the game (Figure 5). The redesigned version of the game also exploited a 3D model of the gameplay area and provided zoom-in/zoom out global, local and ground level views for players and was subsequently deployed in Rotterdam (V2 2003).

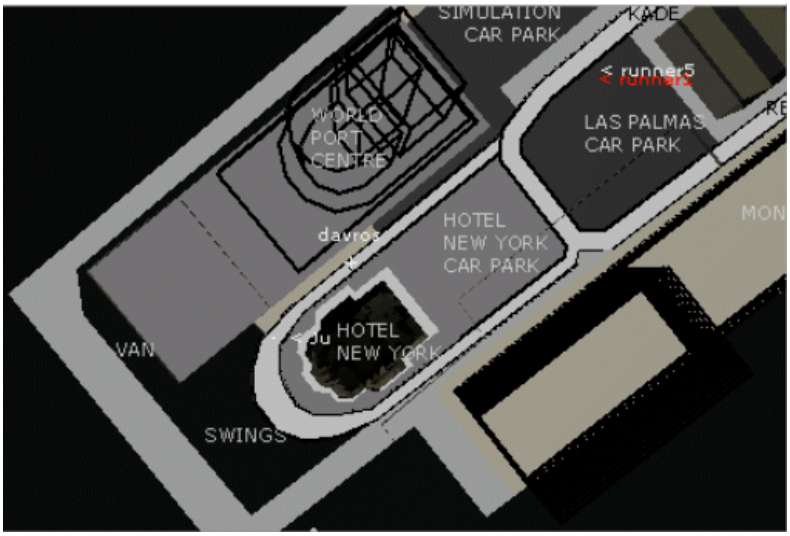

Figure 5. New player interface - exploiting local knowledge

These changes provided a much richer interactional context for players, enabling them to orient one another to runners, to help each other avoid runners, to take evasive action, to organize collaborative gameplay, and to both find and meet one another, as the following edited text log extracts make visible.

Orienting other players to runners

```
#1. WILLEM: Where are the runners?
MARTIN: They're all around Las Palmas car park

#2. JOHN DOE: Runner 4 near cafe Rotterdam
TOBY: Heading up by Las Palmas
JOHN DOE: Runner 4 headed for Las Palmas
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Helping other players to avoid runners

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#3. DANI: Runner 3 at Las Palmas
PHIL: Runner 2 is nearby
CLAUDIA: Shit!!! Runner 3's on our ass
D.BOT: He's still on us - look out Catherine
DANI: Watch out Catherine

#4. SAAB: Mike meet me at cafe Rotterdam
MIKE: Sorry, stalking Anna
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ANNA: That’s okay Mike
SAAB: Stop stalking her then
MIKE: Anna has a nice butt
ANNA: How do you know?
MIKE: Big imagination
ANNA: Well you’re right
SAAB: Mike watch the runner!

Taking evasive action
#5. DAVE: I’m in the south
ANDREW: Runner 4 is in the hotel car park
DAVE: Action
TOMMIE: Christine look right
ANDREW: Run for your lives!
JULES: Run baby run!
CHRISTINE: Thanks!
ANDREW: Runner 4 is west of the swings

#6. TAMA: Runner 1 at Las Palmas car park
ROBERT: North and east is clear
TAMA: Look out Ed! Runners 1 and 2 at Las Palmas

Organizing collaborative gameplay
#7. PAUL: No sign of the runners?
5000: I don’t think so
NOBODY: They are in the car parks
5000: What are they doing there?
NOBODY: Chasing nobody
PAUL: It’s probably a long way to get over here
PAUL: Lets run
5000: Where to?
PAUL: Lets meet the runners

#8. D.BOT: Runner 3 is still by Koolhaas I think
LANDO: Runner 4
SAN: Near Phil now
LANDO: He is heading to the car park
D.BOT: Bring Runner 3 over this way
CHRIS: I’m feeling suicidal

Finding other players
#9. AMMA: Running around to find Anna. Does anybody see her?
ROBERT: Anna is moving towards Hotel New York

#10. PENNY: Hello Steve we’re looking for you
STEVE: I’m near Las Palmas - avoiding Runner 1

#11. VESPER: Jasper where are you?
JASPER: Behind Las Palmas

#12. MARCEL: Ali I’m somewhere around Las Palmas
ALI: How do I find Las Palmas?
MARCEL: Look at the map, right corner

Meeting other players
#13. VESPER: Let’s all gather - makes things more exciting
ANNICK: Where?
VESPER: And when the runners come we scatter
PHIL: This could be interesting when they come running for us
VESPER: Between Las Palmas and Sumatra
ANNICK: OK

#14. JASPER: Hi Vesper
VESPER: Runner 2 is ahead
JASPER: Runner 2 on the move
VESPER: Better get moving
JASPER: I’m outta here
LANDO: Where are the runners?
VESPER: Wait for me!!
JASPER: All right
VESPER: Gather at Las Palmas everyone

Exploiting local knowledge of the gameplay environment provided a valuable resource for players' collaborations, though this is not to say that the game was trouble free. Players often encountered technical problems and collaborated to make sense of them as the following extracts indicate.

```
#15. MARCEL: Attention. Runner 1 is cheating by using his invisible coat
HBAB: What's an invisible coat?
MARCEL: Never mind what the coat is - he can pop out of nowhere

#16. STEVE: Runner 4 keeps seeing me, but I don't always see them
TOBY: Runner 1 you're moving very fast
TRACY: Sure you're not roller-skating?
ADAM: Ah! Where did Runner 2 come from?

#17. MARJOLEIN: Anyone seen the runners?
MELISSA: I think they can turn off their signal
HANNE: I only see two runners - are the rest taking a coffee?
BLASTER: Runner 1 is just a lazy joke
HANNE: If they can turn off their signal that's pretty scary and not
really fair
MELISSA: Tell me about it
MARJOLEIN: Well maybe the satellites don't work properly
```

The problems players encountered were a product of GPS variability and slow network updates and in the absence of working knowledge of the technology, this produced situations of uncertainty for players (Benford et al. 2003). Were the runners cheating? Did they have invisible coats? Were they on roller-skates? Where did come from? Could they turn their signals off? Are they lazy? Or having a joke? Ethnographic studies of the runners' work on the streets of Rotterdam provided further resources for thinking about how we might augment working knowledge of the technology and develop support for collaboration between runners and players alike (Crabtree et al. 2004).

The study revealed that working of knowledge of the technology is in significant respects tied to dealing with interruptions to the game. Working with 'constant interruption' is an irremediable feature of using the technology for two main reasons. Firstly, 802.11b networking has limited coverage. Even though seven wireless access points were distributed across the physical gameplay area (which was roughly 400 metres by 800 metres), the narrow and built up nature of the city streets resulted in many network blackspots where runners could not connect to the game. Secondly, GPS is subject to the contingencies of satellite availability. If too few satellites are visible from a runner's current location (perhaps due to being in the shadow of a building or there being only a few satellites passing overhead at that moment) a runner will not be able to get a GPS 'fix' and will be unable to play the game. Managing such interruptions is, therefore, an essential feature of gameplay for the runners insofar as they must be handled and repaired if interaction is to proceed. The following vignettes elaborate the situated ways in which managing interruptions is tied to the production and use of working knowledge of the technology.

```
Runner 2 on walkie-talkie. Runner 2. I've just lost all players; I've lost
all players!
Runner 2: Looking at handheld. I've got a disconnection here.
```

Figure 6. Seeing a disconnection: losing players

```
The runner can do no other than abandon the chase, and he informs his
colleagues and players alike that he has a specific problem and just where
that problem is located.
Runner 2 on walkie-talkie: Runner 2. Heading seawards on Otto. I am
currently disconnected.
He turns around and starts walking back down the street to the last known
point at which he had connectivity. He arrives at the carpark where he
last checked the handheld.
Runner 2 on walkie-talkie: Runner 2. I've connectivity again. I'm in Vern.
```

Ethnographic study of runners' work shows how working knowledge of the technology emerges and evolves. We can see, for example, how in experiencing a disconnection the runner makes the kind of interruption he is experiencing public knowledge. An interruption is *announced* to the other runners over the walkie-talkie, making others *aware* of the nature of the interruption and the location at which it occurs. The runner repairs the interruption by retracing his steps and moving to a location where he last had connectivity. This strategy trades on and exploits working knowledge of the technology – of knowing that disconnections are transient technical phenomena that may be resolved by moving to a better location – and at the same instructs us how such forms of knowledge are developed: through hands on experience of using the technology *in situ* and through making others aware of and *sharing* knowledge of the interruptions encountered as they occur. Accordingly, over the duration of gameplay, a corpus of working knowledge of 'good' and 'bad' areas of technology use emerges and evolves. The following vignettes sheds light on the use of working knowledge to manage interruptions.

```
Runner 2 on walkie-talkie: Runner 2. I'm in pursuit of Dave.
He runs along a side-street, consulting handheld as he goes, turning left
at the end of the street and going down Wilamena before slowing to a walk.
Runner 2 on walkie-talkie: Runner 2. I'm heading seawards on Wilamena,
waiting for a server update.
He continues walking down the street, looking at the handheld and his
place on the street, seeing the incongruity between his virtual and real
positions.
Runner 2 on walkie-talkie: My GPS is currently 35 metres. My server
position is about 50 metres out.
```

Figure 7. A visible incongruence between virtual and real

```
Runner on walkie-talkie: This is Runner 2. Can Runner 1 and Runner 4 hear
me, or Runner 3 please? Come in.
Runner 2 switches to the technical channel.
Runner 2 on walkie-talkie: This is runner 2 on 4 Zero. I can't get any
response from anyone else on 238 (gameplay channel). Can you please
confirm that the other runners are on 238?
Runner 2 on walkie-talkie: And who else is on 4 Zero (technical channel)
please?
Runner 2: Runners 1 and 3 are having technical trouble. 4's in.
Runner 2 notices Runner 3 on the other side of the street and goes over to
him.
Runner 3: Are you on 238?
Runner 2: I'm on 238, yeah.
Runner 3: OK.
Runner 2: I just switched back.
Runner 2: Looking at Runner 3's handheld. What's the problem?
Runner 3: Just not moving.
Runner 2: Yeah, I'm having the same. Looks like we have a bit of a server
screw up.
Runner 3: All right.
Runner 2 starts walking away from Runner 3.
Runner 2 on walkie-talkie: This is Runner 2. I've had no GPS update in 2
or 3 minutes.
Runner 2 walks towards the seafront, where he knows there is usually good
GPS coverage when it's available.
```

This vignette makes it visible that working with constant interruption consists of exploiting working knowledge of the technology to conduct *diagnostic work*. While the nature of an interruption might be readily apparent – that the runner is 'stuck' as can be seen in the visible incongruity between the runner's virtual and the real positions – the source and/or the extent of such interruptions is not always clear. Runners do not know whether being stuck is a result of server problems, poor satellite availability or some other technical matter such as the disconnection of their GPS armband antenna or receiver from the rest of their equipment (which occasionally happened as they were running for hours at a time, placing the equipment under considerable stress). Similarly, a runner does not know if it is an interruption only they themselves are experiencing or that others are experiencing too. And knowing such things is important because it informs the runner's decision-making – i.e. helps them establish a sense of what it might be appropriate to do next in order to manage the interruption that is currently to-hand.

So runners need to diagnose interruptions in order to handle them. Diagnosis is a collaborative achievement and the vignette instructs us as to some of the ways in which that achievement is collaborative. On experiencing an interruption that is not quickly repaired runners consult one another via the walkie-talkies to establish which *channel* they are on (gameplay or technical) and to determine the gameplay *status* of others (whether others are playing the game or experiencing some interruption). The

absence of a response from other runners in this case suggests that the interruption may be *widespread* and so the runner next consults control room staff via the walkie-talkie to establish whether or not that is the case.

Runners also collaborate with one another directly (face-to-face) as they meet through happenstance on the streets. Although serendipitous in nature, this form of collaboration is nonetheless important. It allows runners not only to see for themselves the interruptions others are experiencing but also, as with indirect collaboration (via the walkie-talkie) with control room staff, to establish the *generality* of the interruptions. And therein lies the nub of the matter: diagnostic work is concerned to establish the generality of interruptions, which in turn informs their decision-making. Diagnostic work enables a runner to determine whether or not the interruption he is encountering is his alone, and related to his *personal kit*, or being experienced by others as well and related to the *game's technical infrastructure*. This, in turn, suggests the next move in managing the interruption: moving off to a better location and waiting for a GPS update as more satellites become available, for example, or restarting the handheld computer, or even restarting the game if needs be.

The next vignette elaborates other important features of the runners' diagnostic work.

```
Runner 1 is walking around the Los Palmas carpark looking at her handheld.
She crosses the road on Wilamena, going towards the seafront. She walks
across Simulation Carpark and then stops suddenly, holding the handheld up
in front of her.
Runner 1 on walkie-talkie: Runner 1. I've got locations on players but I'm
stuck in New York.
Runner 1 turns around and starts to walk back towards Los Palmas carpark.
She stops at the roadside, looking closely at the handheld. She turns
around again and walks back towards the seafront.
```

Figure 8. Diagnostic work: moving from place-to-place

```
Runner 1 then heads back towards the road. She turns left and walks up
Wilamena, crosses the road, turns down the first alley she comes to on her
right and then turns right again at the end of that, heading towards Los
Palmas. Halfway down the street she comes across John, one of the control
room staff who also monitors the status of work on the streets as and when
technical troubles arise.
Runner 1: John, my position's gone really bizarre as in its not saying
where I am. And I know that it takes a while but I seem to be getting
stuck in really bizarre places. Like, I am not in Simulation carpark at
the moment.
John: Looking at handheld. No. The best thing to do is to stand out in the
middle of the carpark and just do a reset.
They both go to Los Palmas carpark and John resets the handheld.
Runner 1: Brilliant, are we in the right place?
John: We've not got GPS yet. But, I think there's only about 3 satellites
or something.
Runner 1: Runner 4's just dropped out of GPS.
```

```
They look up from the handheld and see Runner 4 across the road, standing
beneath a waveLAN base station (where there should be good connectivity).
```

Figure 9. Seeing that others are interrupted too

```
John: Looking across road. Runner 4 seems to be waiting.
Runner 1: Looking at handheld. Yeah he is. He's just disappeared off here.
Runner 1 on walkie-talkie: Runner 1. Runner 4 can you here me?
John: Are any runners running?
Runner 1: No.
John: Everybody's down?
Runner 1: I think so.
Runner 1 on walkie-talkie: Runner 2 what is your current situation?
Runner 1: He's got GPS.
Runner 1: Hup, I've got GPS.
```

This vignette extends our understanding of diagnostic work. It first draws attention to a strategy for recognizing the *seriousness* of an interruption: moving from place-to-place. The strategy establishes that the interruption is more than a matter of a slow update in that it provides for its repair and, in failing to effect a repair, brings to light a technical gremlin that results in the runner 'getting stuck in really bizarre places'. The situation is repaired through serendipitous collaboration with a member of the control room staff, who resets the handheld to eliminate one possible source of trouble. The sequence also makes it visible that runners consult one another when encountering serious interruptions, not only collaborating indirectly via the walkie-talkies, but also through *surreptitious monitoring* [11] of the streets to see what others are doing and to establish whether or not the interruptions to-hand are local (i.e., of this kit) or general (of the technological infrastructure). The interruption in this case transpires to be general, which affects all the runners.

Breaching Experiment #3. Here and Now

Once again, the phenomena seen in the breach – the troubles players' encounter and runners management of interruptions – provides a concrete resource driving innovation. Having successfully augmented local knowledge of the gameplay environment, providing players with a key resource for collaboration, we now consider augmenting working knowledge of the technology to support collaboration between runners and players alike. This work is ongoing and below we present design prototypes that will, in turn, be deployed in the wild and treated as breaching experiments.

Development work here involves giving the runners and players access to information about the expected spatial availability of GPS and WiFi by colouring the gameplay map to show 'good' and 'bad' areas of coverage. This allows the runners to supplement their personal experience and shared knowledge with timely infrastructure-derived data so that they know where to go in order to rejoin the game, and provides a resource for players to make sense of the troubles they encounter and

to orchestrate their actions accordingly (avoiding 'blackspots', for example, where sudden 'jumps' may occur). Augmentation builds on an existing mechanism in CYSMN where artists configure the game by colouring maps. At present, they colour in possible start positions for online players (the game engine chooses one of these each time an online player is introduced into the game) and also areas such as buildings and water where runners are not allowed to appear (if a GPS update places a runner inside one of these regions, the system moves their visible position to be the nearest location that is just outside of it). Our proposed extension involves creating *dynamic* colour maps that are updated from a mixture of logged, live and predicted information. We have developed two prototype visualisations as first steps towards this.

Our first design prototype visualises the history of GPS availability and error as reported by GPS receivers in order to build up a picture of 'good' and 'bad' locations. Figure 10 shows a visualisation of GPS error over a two-hour game session that has been overlaid onto the map of the game zone. The solid black areas within the game zone are buildings and the surrounding area is water. Coloured areas are locations where a GPS reading was successfully transmitted to the game server over Wifi and logged. Green blooms signify readings with larger errors (5 meters or above) and blue blooms signify readings with smaller errors (approaching 1 meter). Larger errors also produce larger blooms of colour due to the uncertainty in the reported position. Grey areas with no colour show locations where no readings were obtained, either because there was no GPS or WiFi coverage, because they were inaccessible to runners (some areas were fenced off), or because runners simply never ventured there. This serves a dual purpose of revealing areas of expected WiFi connectivity and also giving historical clues to the generally quality of GPS accuracy that might be anticipated in different places.

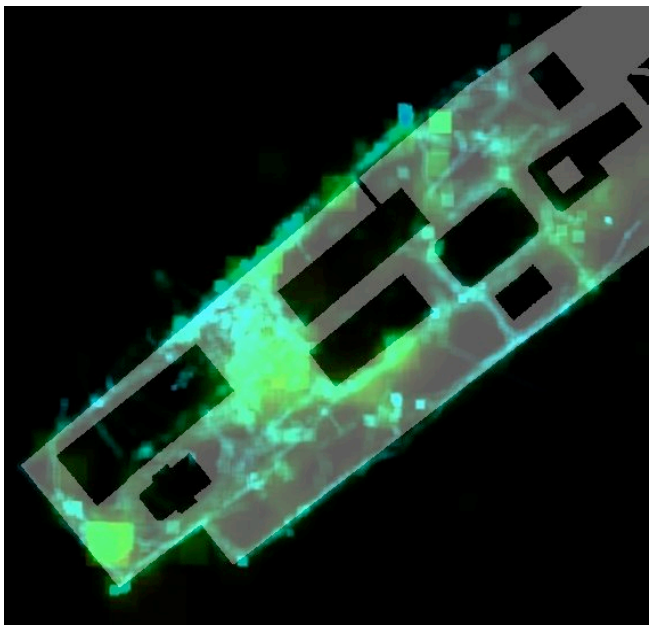

Figure 10. Visualization of GPS history from CYSMN

We know that GPS exhibits considerable variation over time as the GPS satellites move across the sky overhead. Our second design prototype predicts the likely availability of GPS at different locations on the streets at *specific times,* rather than the broader historical trends revealed by the first visualisation. This visualisation takes the 3D model of the game zone and information about the positions of GPS satellites at a

given moment in time and for each location on the ground, calculates how many satellites are in its direct line of sight.

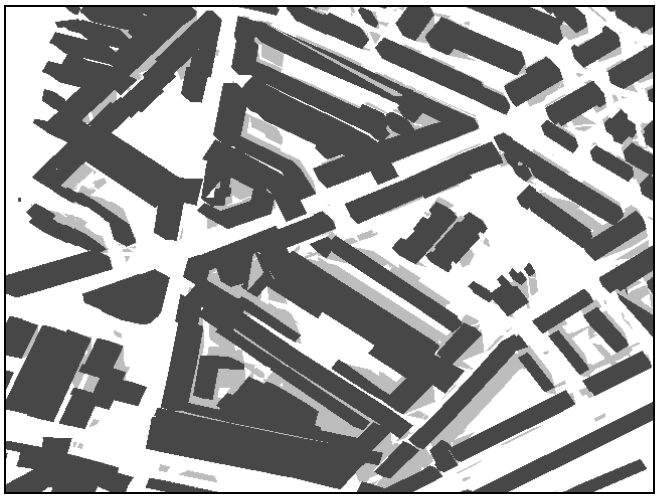

Figure 11. Visualisation of predicted GPS availability

The output is a map of expected 'good' and 'bad' areas of GPS availability as shown in Figure 11. In this example (which is an area of central London), buildings are shaded black, areas of likely good GPS (with line or sight to three or more satellites) are shaded white, and areas of poor GPS (line of sight to less than three satellites) are shaded grey. Following trials in the wild (Uncle Roy 2004), we are also considering providing runners with a self-reporting mechanism that logs positions where interruptions are experienced, which may also be used to augment the gameplay map with working knowledge of the technology. Access to such information, would give the runners much more timely and fine-grained hints to resolving GPS problems than might easily be acquired through first-hand experience, and provide players with definite insights into the troubles at-hand and so inform their sense-making and decision-taking. Ongoing work is exploring how these visualizations can be combined and integrated with the runners' and players' interfaces to provide effective support.

Technomethodology: A Hybrid Approach to Innovation

The incorporation of ethnomethodology in professional systems development prompted the call for the approach to move from design critique to design practice and the invention of the future. Initial responses to challenge saw ethnomethodology configured to fit into product development processes. However, the vast majority of ethnomethodological studies are conducted, in a design context, in academic and commercial research labs rather than product development settings, where emphasis is placed on innovation and not product construction. It is in this context that the possibility of moving beyond a service-provider role and forging a hybrid relationship between ethnomethodology and design has emerged. The potential to merge ethnomethodology and design was originally explored through reflection on ethnomethodological principles and insights and the implications these might have for the development of new and emerging technologies. In this paper the relationship has been developed by operationalising ethnomethodological principles. In particular, the treatment of public performances as breaching experiments has been advocated. The rationale at work here suggests that deploying innovative technologies in the wild serves to provoke or 'call forth' practice when participants in a performance attempt to make the technology work.

We have articulated this approach by practical example, describing the ad hoc interactional practices involved in the production of a mixed reality game that takes place online and on the streets. Studies of the technology-in-use in the wild have drawn particular attention to the importance of the production and use of a common stock of knowledge. This consists of local knowledge of the environment in which the technology is used and working knowledge of GPS technology. These studies have, in turn, provided concrete resources driving innovation and we have, accordingly, augmented the gameplay environment with local knowledge to promote and support collaboration amongst online players. This has proved to be highly successful, though technical problems caused troubles for players in the absence of working knowledge of the technology. Studies of the situated ways in which runners on the streets produce and exploit working knowledge to manage technical interruptions have subsequently informed the development of an augmented gameplay map that supports diagnostic work on the streets and at same time provides online players with a concrete resource with which to make sense of runners' actions.

Staging public performances and treating them as breaching experiments serves to elaborate the social circumstances that innovative technology use turns upon or relies and, in this case, the approach has informed the development of mobile, wireless, and GPS applications. This configuration of the relationship between ethnography and design, which places emphasis on situating technology in real world settings through performance, encourages ethnomethodologists to don the practical mantle of design and attend to the specific challenges involved in exploring and developing the potential of new and emerging technologies. Furthermore, it encourages designers to adopt the analytic mentality of ethnomethodology, employing ethnomethodological studies of the concerted work of performance to better understand the technology's situated character and potential. It leads to a hybrid research and development model where technology becomes a vehicle for social research and the results of that research in turn, and demonstrably, propel innovation and the invention of the future.

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References

Archive (2001) *Can You See Me Now? Sheffield*, www.canyouseemenow.co.uk/

Azuma, R. (1999) "The challenge of making augmented reality work outdoors", *Mixed Reality: Merging Real and Virtual Worlds*, pp. 379-390, Springer-Verlag.

Benford, S., Fraser, M., Reynard, G., Koleva, B. and Drozd, A. (2002) "Staging and evaluating public performances as an approach to CVE research", *Proceedings of the 4th ACM International Conference on Collaborative Virtual Environments*, pp. 80-87, Bonn, Germany, ACM Press.

Benford, S., Anastasi, R., Flintham, M., Drozd, A., Crabtree, A., Greenhalgh, C., Tandavanitj, N., Adams, M. and Row-Farr, J. (2003) "Coping with uncertainty in a location-based game", *IEEE Pervasive Computing*, vol.2 (3), pp. 34-41.

Benford, S., Crabtree, A., Flintham, M., Drozd, A., Anastasi, R., Tandavanitj, N., Adams, M. and Row-Farr, J. (2004) "Can You See Me Now?", (under review) *ACM Transactions on Computer-Human Interaction*, ACM Press.

BBC (2001) *Shooting Live Artists*, www.bbc.co.uk/arts/ shootinglive/shootinglive1/blasttheory

Bowers, J., Button, G. and Sharrock, W.W. (1995) "Workflow from within and without", *Proceedings of the Fourth European Conference on Computer Supported Cooperative Work*, pp. 309-324, Stockholm, Sweden: Kluwer Academic Publishers.

Button, G. (ed.) (1992) *Technology in Working Order: Studies of Work, Interaction, and Technology*, London: Routledge.

Button, G. and Dourish P. (1996) "Technomethodology: paradoxes and possibilities", *Proceedings of the 1996 CHI Conference on Human Factors and Computing*, pp. 19-26, Vancouver, Canada: ACM Press.

Button, G. and Harper, R. (1996) "The relevance of 'work-practice' for design", *Computer Supported Cooperative Work: The Journal of Collaborative Computing*, vol. 4 (4), pp. 263-280.

Calvey, D., Hughes, J., O'Brien, J., Rodden, T. and Rouncefield, M. (1997) *Proceedings of the 20th Information Systems Research in Scandinavia Conference*, Hanko, Norway: IRIS. http://iris.informatik.gu.se/conference/iris20/10.htm

COMIC Deliverable 2.1 (1994) *Informing CSCW Requirements*, Esprit Basic Research Project 6225, Lancaster University: Computing Department. ftp://ftp.comp.lancs.ac.uk/pub/comic/

Crabtree, A (2001) "On the practical availability of work-practice", *Ethnographic Studies* (eds. Francis, D., Hester, S., Hughes J.A., and Sharrock, W.W), vol. 6, pp. 7-16.

Crabtree, A. (2003) *Designing Collaborative Systems: A Practical Guide to Ethnography*, London: Springer-Verlag.

Crabtree, A. (2004) "Design in the absence of practice: breaching experiments", *Proceedings of the 2004 ACM Symposium on Designing Interactive Systems*, August 1st-4th, Cambridge, Massachusetts: ACM Press.

Crabtree, A., Benford, S., Rodden, T., Greenhalgh, C., Flintham, M., Anastasi, R., Drozd, A., Adams, M, Row-Farr, J., Tandavanitj, N. and Steed, A. (2004) "Orchestrating a mixed reality game 'on the ground'", *Proceedings of the 2004 CHI Conference on Human Factors in Computing System*, pp. 391-398, Vienna: ACM Press.

Flintham, M., Anastasi, R., Benford, S., Hemmings, T., Crabtree, A., Greenalgh, C., Rodden, T., Tandavanitj, N., Adams, M. and Row-Farr, J. (2003) "Where on-line meets on-the-streets: experiences with mobile mixed reality games", *Proceedings of the 2003 CHI Conference on Human Factors in Computing Systems*, pp. 569-576, Florida: ACM Press.

Garfinkel (unpub. manu. #1) "Lebenswelt mathematics, its discovery, its specification, and some consequences", *University of California Los Angeles*: Department of Sociology and Anthropology.

Garfinkel, H. (unpub. manu. #2) "Parsons' primer – ad hoc uses", *University of California Los Angeles*: Department of Sociology and Anthropology.

Garfinkel, H (unpub. manu. #3) "About the missed orderliness of ordinary activities", *University of California Los Angeles*: Department of Sociology and Anthropology.

Garfinkel, H. (1967) "Studies of the routine grounds of everyday activities", *Studies in Ethnomethodology*, pp. 35-75, Englewood Cliffs, New Jersey: Prentice-Hall.

Garfinkel, H. (ed.) (1986) *Ethnomethodological Studies of Work*, London: Routledge and Kegan Paul.

Garfinkel, H. (2001) *Ethnomethodology's Program: Working Out Durkheim's Aphorism* (ed. Rawls, A.), Rowman and Littlefield, Lanham, Maryland.

Grudin, J. and Grinter, R. (1995) "Ethnography and design", *Computer Supported Cooperative Work: The Journal of Collaborative Computing*, vol. 3 (1), pp. 55-59.

Heath, C. and Luff, P. (1991) "Collaborative activity and technology design: task coordination in London Underground control rooms", *Proceedings of the Second European Conference on Computer Supported Cooperative Work*, pp. 65-80, Amsterdam, the Netherlands: Kluwer Academic Publishers.

Hughes, J.A., Randall, D. and Shapiro, D. (1993) "From ethnographic record to system design: some experiences from the field", *Computer Supported Cooperative Work: An International Journal*, vol. 1 (3), pp. 123-141.

Luff, P., Hindmarsh, J. and Heath, C. (eds.) (2000) *Workplace Studies: Recovering Work Practice and Informing System Design*, Cambridge: Cambridge University Press.

Lynch, M. (1994b) "From quiddity to haecceity: ethnomethodological studies of work", *Scientific Practice and Ordinary Action*, pp. 265-308, Cambridge University Press, Cambridge.

Madsen, O.L., Møller-Pedersen, B. and Nygaard, K. (1993) "Conceptual framework", *Object-Oriented Programming in the BETA Programming Language*, pp. 289-322, New York: Addison-Wesley.

Mann, S., Nolan, J. and Wellman, B. (2003) "Sousveillance", *Surveillance & Society*, vol. 1 (3), pp. 331-355.

Mogensen, P. and Trigg, R. (1992) "Artefacts as triggers for participatory design", *Proceedings of the 1992 Participatory Design Conference*, pp. 55-62, Computer Professionals for Social Responsibility.

Prix Ars Electronica: International Competition of Cyberarts (2003) *Golden Nica Award for Interactive Arts*, www.aec.at/en/prix/winners2003.asp

Schutz, A. and Luckmann, T. (1974) *The Structures of the Lifeworld*, Heinemann.

Sharrock, W.W. (2000) "Ethnography in the workplace", paper presented at Tokyo University, September 2000. http://les.man.ac.uk/sociology/staff/sharrock.shtm

Sommerville, I. and Sawyer, P. (1997) *Requirements Engineering: A Good Practice Guide*, New York: John Wiley.

Suchman, L. (1987) *Plans and Situated Actions: The Problem of Human-Machine Communication*, Cambridge: Cambridge University Press.

Uncle Roy (2004) www.uncleroyallaroundyou.co.uk

V2 (2003) *Can You See Me Now? Rotterdam*, www.canyouseemenow.v2.nl