Working with Digital Records: Developing Tool Support

Andy Crabtree, Andy French, Chris Greenhalgh, Tom Rodden and Steve Benford

School of Computer Science & IT, University of Nottingham, Jubilee Campus, Nottingham NG8 1BB, UK.

Email address of corresponding author: axc@cs.nott.ac.uk

Abstract. An ongoing strand of research in e-Social Science is directed towards understanding the potential of new forms of digital record to support social science inquiry. In this paper we address the challenges raised by this programme in the effort to understand interaction in emerging digital environments. Digital records generated through participants' interactions provide new resources to support ethnographic inquiry. Building on and extending prior research in the field, we outline specific requirements for tools to support the work whereby digital records are made into objects that support ethnographic inquiry. We review the 'work that makes digital records work' to highlight the kinds of operations that are performed on digital records as a feature of this work, which in turn highlight areas for technical support. In unpacking the work implicated in the use of digital records we not only identify requirements shaping the development of e-social science applications, we also uncover and articulate a significant substantive finding to emerge from this kind of research: namely, the fundamental difference between the recorded order of events and the 'real world, real time' interactional order of events and the implications this has for continued study of interaction in emerging digital environments.

Introduction

The e-Social Science Research Node *DReSS* explores the potential to develop new kinds of digital record for use by social scientists. One strand of this programme is dedicated to understanding the interactional character of technology use. This is not an attempt to extend the 'virtual ethnography' programme (Hine 1998) however, but to bring ethnomethodologically informed ethnography (or ethnography as we will simply call it from here on in) to bear on the problem of understanding interaction in digital environments (Crabtree et al. 2000). This kind of ethnography has proved to be of considerable purchase in the effort to understand the interactional character of technology use in the fields of Computer Supported Cooperative Work and Human Computer Interaction alike. The advent of 'ubiquitous computing' raises new challenges for the approach however, distributing interaction across a burgeoning array of different applications and devices, some online, some mobile, each exploiting different mechanisms of interaction. If ethnographers are to develop coherent understandings of interaction in these emerging environments it is necessary that they reconcile the various differentially distributed fragments of interaction that populate them (Crabtree et al. 2006a).

While this research is targeted and specific we believe that there may be some general utility to the tools that are being developed to support this endeavour. Interaction increasingly takes place in digital environments and computers are today a commonplace feature of a wide range of everyday activities beyond the workplace. The general utility of this strand of research is to provide tools that enable social scientists to capture features of interaction in digital environments and marry them to existing resources, such as video, audio, documents, photographs, etc., to create more comprehensive digital records of interaction for analysis. When we refer to 'digital records' we refer to the features of interaction that are recorded within digital environments by the computing system and the combination of these recordings with external resources gathered by the social scientist (Crabtree and Rouncefield 2005). In our own work external resources are largely in the form of video recordings of interaction but a wide range of external resources may similarly be digitized and incorporated into the record. The digital record may be viewed as a natural extension of the ethnographic record; that is, as a repository which gathers together all the materials the ethnographer has gathered in the course of his or her inquiries. What is distinctively novel about the digital record is the ability of new technologies to move beyond recording features of human-computer interaction (key strokes, mouse movements, gaze, etc.) to record features of *social interaction* in the course of their use and to subsequently make them available as resources to the analyst as well (Crabtree et al. 2006b).

Methodologically the initial challenge is to reconcile the various resources gathered in order to construct coherent representations for analysis. In our own case, the challenge is one of reconciling the fragments of interaction that populate emerging digital environments. Interaction is fragmentary in two distinct senses in this context. It is fragmentary for users of the technology in that interaction, as noted above, is distributed across differentially distributed interaction mechanisms. Online users may communicate with mobile users via text messages, for example, whereas mobile users may respond via audio messages. These two forms of communication are not symmetrical and determining the meaning of text or audio messages often requires some practical effort or 'work' on the part of recipients (Crabtree and Rodden 2006). In effect, the users must reconcile the various fragments of interaction that they encounter in emerging digital environments then if they are to carry out collaborative activities. It is also necessary for the ethnographer to reconcile the distributed fragments of interaction if he or she is to construct a coherent representation of interaction in emerging digital environments. Naturally much may be gleaned by videoing interaction, by following a mobile user or sitting alongside an online user. It is also the case, however, that the digital record makes a much richer representation of interaction possible, providing access to interaction in a way that was hitherto difficult if not impossible by providing resources from within the interactional situation. That is not only on the streets with a mobile user, or alongside an online user, but from within the digital environment itself (Benford et al 2003). Combining resources internal to interaction within digital environments with resources detailing interaction external to digital environments enables a more comprehensive account of interaction to be developed then (Brown 2003, Crabtree 2004, Barkhuus et al. 2005).

Below we consider the work that is involved in making digital system recordings work for purposes of ethnographic analysis. We use the case of a location mixed reality game called *Uncle Roy All Around You*[*] to illustrate what is involved in combining digital recordings with video to construct representations of interaction and to inform the development of computational mechanisms that support the work of reconciliation. The game exploits PDAs and mobile telephone services to explore a self-positioning approach that might be adopted when GPS breaks down (Benford et al. 2004). This is a low-tech location-based system in

[*] www.blasttheory.co.uk/bt/work_uncleroy.html

which mobile users (street players) follow clues to find their way around a city and report their own positions in the game in the course of making their way to Uncle Roy's office. The reported positions of street players are made available to online players, who track street players movements in a parallel virtual environment. They communicate with street players and other online players via text messages. Street players communicate with online players by sending short (7 second) audio messages via the PDA. Street players and online players must collaborate to find a postcard that is located somewhere in the physical city. Each online player must find a particular postcard, any card will not do. When the right postcard is found information is sent to the online player, which he or she uses to guide the street player to Uncle Roy's office. The system records clues, text messages and audio messages for subsequent analysis by the ethnographer. Below we reflect on the work whereby system recordings are combined with external recordings, focusing on extraction, synchronization, and the transition from the recorded order of events to the interactional order of events before moving on to briefly outline computer-based mechanisms to support the enterprise.[1]

Working with System Recordings

Events recorded by the system in the course of player interaction in *Uncle Roy All Around You* were combined in a temporally ordered spreadsheet, where temporal order was determined by the time an event was registered by the game server (Figure 1). Audio messages are referenced in the spreadsheet and provided separately in mp3 files, each labeled as it is in the spreadsheet (e.g., audio_id_82537_time_1083871041921). These resources are then passed to the ethnographer to be combined with external resources for analysis. Although the system recording 'logs' internal features of interaction, those features are not readily accessible or amenable to analysis. In simple terms the system record is messy, largely unintelligible, and full of noise. In order to turn it into a usable resource for the purposes of analysis it is necessary to clean it up so that the ethnographer can identify salient features of interaction. In this particular case 'salient features' consist of those features of the system record that enable the ethnographer to understand interaction between online and street players: clues and messages. Importantly, salience is determined with reference to external resources, in this case the video of interaction that the ethnographer has captured by accompanying players on the streets. Cleaning the system record consists of identifying parts of it that 'sit alongside' external resources then and of converting obscure machine renderings of events (such as player identity, Column C in Figure 1, for example) into readily intelligible renderings (such as proper names). Cleaning the record also requires that non-relevant features be stripped out. 'Non-relevant' features consist in this case of interactional features such as text and audio messages that are not related to what is 'going on' in the video. Basically the system recording can be seen to contain and represent multiple interactional threads. Only some of these threads are relevant to the discrete sequences of interaction recorded on video and so the others must be removed as they have no work to do in the analysis of interaction here. The work of cleaning the system record continues then with an eye towards identifying and extracting only those features that relate to the interactional sequences recorded on video. In this case, what is of interest are the interactional threads that pertain to a street player called Patrick and online players called Venom, Nicole and Dave. So cleaning up the record involves extracting interactional threads between particular

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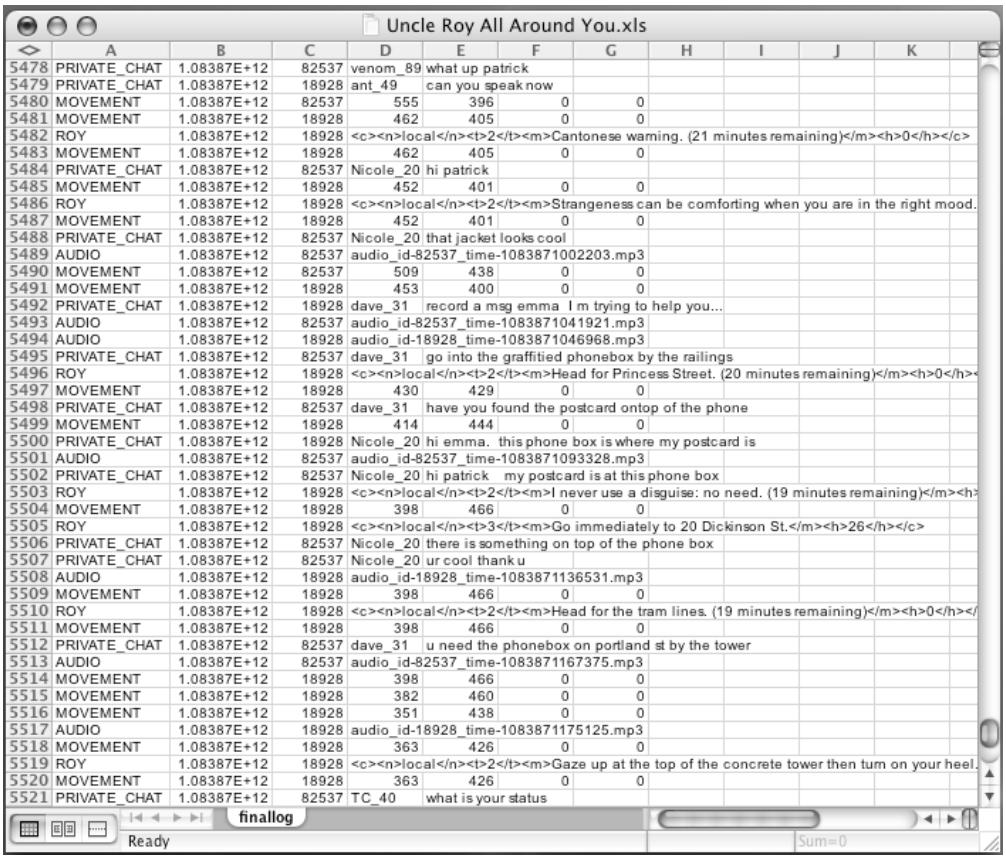
1 The transition from recorded order to interactional order is not, as one of the reviewers of this paper suggests, simply a "bog-standard" ethnomethodological matter of recognizing the inadequacies of formal records (see Lynch 1993 for a classic example of the point being made here). System records are not formal records; rather they automatically capture features of interaction that occur within a digital environment and on no other basis than time. In doing so, and for reasons that will be addressed shortly, they provide a beguiling representation of interaction. Consequently there is a need to re-order digital records for analytic purposes to represent (in our case) the interactional order of events (and it may be that they need to be re-ordered in other ways for different analytic purposes).

participants from the flow of overlapping threads between the multiple participants represented in the record (Figure 2).



Uncle Roy All Around You.xls

	A	B	C	D	E	F	G	H	I	J	K
5478	PRIVATE_CHAT	1.08387E+12	82537	venom_89	what up patrick						
5479	PRIVATE_CHAT	1.08387E+12	18928	ant_49	can you speak now						
5480	MOVEMENT	1.08387E+12	82537	555	396	0	0				
5481	MOVEMENT	1.08387E+12	18928	462	405	0	0				
5482	ROY	1.08387E+12	18928	<c><n>local</n><t>2</t><m>Cantonese warning. (21 minutes remaining)</m><h>0</h></c>							
5483	MOVEMENT	1.08387E+12	18928	462	405	0	0				
5484	PRIVATE_CHAT	1.08387E+12	82537	Nicole_20	hi patrick						
5485	MOVEMENT	1.08387E+12	18928	452	401	0	0				
5486	ROY	1.08387E+12	18928	<c><n>local</n><t>2</t><m>Strangeness can be comforting when you are in the right mood.							
5487	MOVEMENT	1.08387E+12	18928	452	401	0	0				
5488	PRIVATE_CHAT	1.08387E+12	82537	Nicole_20	that jacket looks cool						
5489	AUDIO	1.08387E+12	82537	audio_id-82537_time-1083871002203.mp3							
5490	MOVEMENT	1.08387E+12	82537	509	438	0	0				
5491	MOVEMENT	1.08387E+12	18928	453	400	0	0				
5492	PRIVATE_CHAT	1.08387E+12	18928	dave_31	record a msg emma I m trying to help you...						
5493	AUDIO	1.08387E+12	82537	audio_id-82537_time-1083871041921.mp3							
5494	AUDIO	1.08387E+12	18928	audio_id-18928_time-1083871046968.mp3							
5495	PRIVATE_CHAT	1.08387E+12	82537	dave_31	go into the graffitied phonebox by the railings						
5496	ROY	1.08387E+12	18928	<c><n>local</n><t>2</t><m>Head for Princess Street. (20 minutes remaining)</m><h>0</h>							
5497	MOVEMENT	1.08387E+12	18928	430	429	0	0				
5498	PRIVATE_CHAT	1.08387E+12	82537	dave_31	have you found the postcard ontop of the phone						
5499	MOVEMENT	1.08387E+12	18928	414	444	0	0				
5500	PRIVATE_CHAT	1.08387E+12	18928	Nicole_20	hi emma. this phone box is where my postcard is						
5501	AUDIO	1.08387E+12	82537	audio_id-82537_time-1083871093328.mp3							
5502	PRIVATE_CHAT	1.08387E+12	82537	Nicole_20	hi patrick my postcard is at this phone box						
5503	ROY	1.08387E+12	18928	<c><n>local</n><t>2</t><m>I never use a disguise: no need. (19 minutes remaining)</m><h>							
5504	MOVEMENT	1.08387E+12	18928	398	466	0	0				
5505	ROY	1.08387E+12	18928	<c><n>local</n><t>3</t><m>Go immediately to 20 Dickinson St.</m><h>26</h></c>							
5506	PRIVATE_CHAT	1.08387E+12	82537	Nicole_20	there is something on top of the phone box						
5507	PRIVATE_CHAT	1.08387E+12	82537	Nicole_20	ur cool thank u						
5508	AUDIO	1.08387E+12	18928	audio_id-18928_time-1083871136531.mp3							
5509	MOVEMENT	1.08387E+12	18928	398	466	0	0				
5510	ROY	1.08387E+12	18928	<c><n>local</n><t>2</t><m>Head for the tram lines. (19 minutes remaining)</m><h>0</h></							
5511	MOVEMENT	1.08387E+12	18928	398	466	0	0				
5512	PRIVATE_CHAT	1.08387E+12	82537	dave_31	u need the phonebox on portland st by the tower						
5513	AUDIO	1.08387E+12	82537	audio_id-82537_time-1083871167375.mp3							
5514	MOVEMENT	1.08387E+12	18928	398	466	0	0				
5515	MOVEMENT	1.08387E+12	18928	382	460	0	0				
5516	MOVEMENT	1.08387E+12	18928	351	438	0	0				
5517	AUDIO	1.08387E+12	18928	audio_id-18928_time-1083871175125.mp3							
5518	MOVEMENT	1.08387E+12	18928	363	426	0	0				
5519	ROY	1.08387E+12	18928	<c><n>local</n><t>2</t><m>Gaze up at the top of the concrete tower then turn on your heel.							
5520	MOVEMENT	1.08387E+12	18928	363	426	0	0				
5521	PRIVATE_CHAT	1.08387E+12	82537	TC_40	what is your status						

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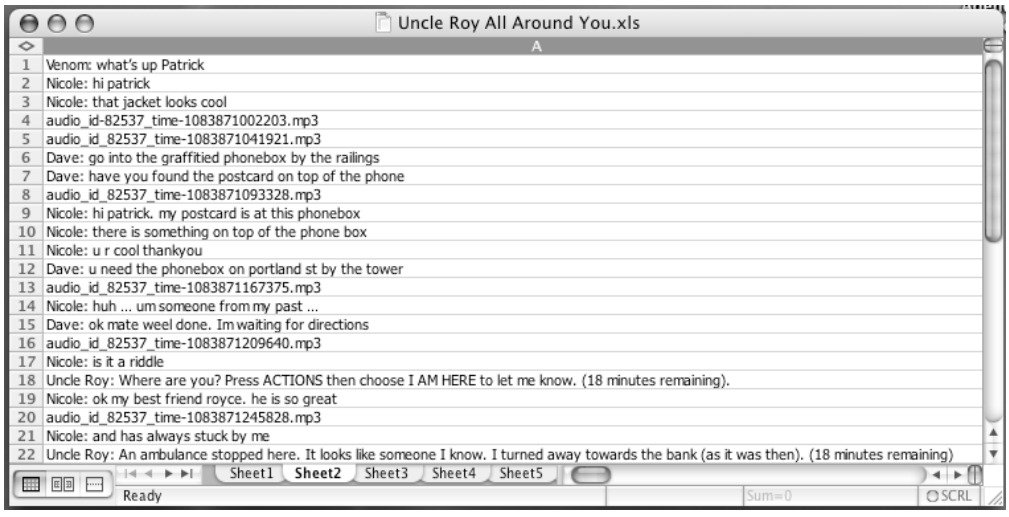
Ready

Sum=0

Figure 1. Snapshot from system recording of interaction.



Uncle Roy All Around You.xls

	A
1	Venom: what's up Patrick
2	Nicole: hi patrick
3	Nicole: that jacket looks cool
4	audio_id-82537_time-1083871002203.mp3
5	audio_id_82537_time-1083871041921.mp3
6	Dave: go into the graffitied phonebox by the railings
7	Dave: have you found the postcard on top of the phone
8	audio_id_82537_time-1083871093328.mp3
9	Nicole: hi patrick. my postcard is at this phonebox
10	Nicole: there is something on top of the phone box
11	Nicole: u r cool thankyou
12	Dave: u need the phonebox on portland st by the tower
13	audio_id_82537_time-1083871167375.mp3
14	Nicole: huh ... um someone from my past ...
15	Dave: ok mate weel done. Im waiting for directions
16	audio_id_82537_time-1083871209640.mp3
17	Nicole: is it a riddle
18	Uncle Roy: Where are you? Press ACTIONS then choose I AM HERE to let me know. (18 minutes remaining).
19	Nicole: ok my best friend royce. he is so great
20	audio_id_82537_time-1083871245828.mp3
21	Nicole: and has always stuck by me
22	Uncle Roy: An ambulance stopped here. It looks like someone I know. I turned away towards the bank (as it was then). (18 minutes remaining)

Sheet1 Sheet2 Sheet3 Sheet4 Sheet5

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Sum=0

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Figure 2. Interactional threads relevant to interaction on video.

What we are left with is a rather sparse representation of interaction and there is a need now to 'thicken' it up, *pace* Gilbert Ryle (1971) rather than Clifford Geertz (1973),[2] by adding the contents from other resources. Thus, and for example, the contents of audio files might be added, which first requires that the audio files be transcribed. There are of course different methods of transcription and the more exacting of these, such as Conversation Analysis

2 See Crabtree (2003) for a discussion of the distinction.

(Sacks et al. 1974), might benefit by converting system time (see Column B, Figure 1) into ordinary time to support fine-grained transcription. Once transcribed, the contents of audio files then need to be synchronized with the text content of the record (Figure 3).

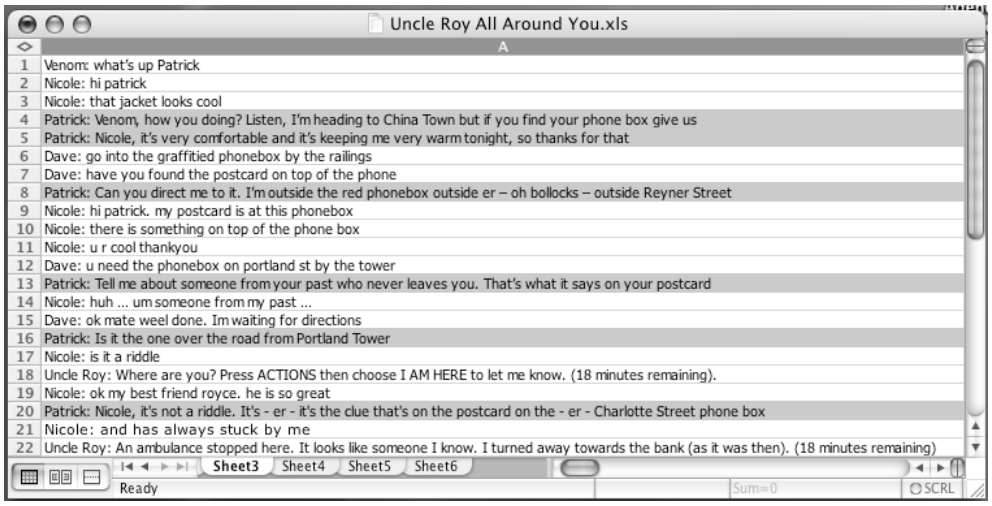

Figure 3. Synchronizing audio and text messages (audio content highlighted).

The job of thickening the representation of interaction and synchronizing internal and external resources continues by adding the contents of the video, transcribing the talk it contains *and* describing the practical action and collaborations that the player engages in on the streets (Figure 4). The combination of internal and external resources enables the ethnographer to reconcile the various fragments of distributed interaction that are contained in various recordings. In turn this provides for richer description of interaction between street players and online players involved in particular sequences of interaction and supports subsequent analysis of its 'situated' character (Suchman 1987). The assembled record is both analytically interesting and troublesome, however. Firstly, the intertwining of text content, audio content and video content brings the record to life in that the contents of the assembled record start to assume some kind of recognizable sense. Unlike the representation of interaction in Figure 1, Figure 4 allows us to see that such things as greetings and introductions are made, that collaboration sometimes goes no further, that the local knowledge of passing members of the public is drawn upon by street players to navigate the city streets, that instructions are issued by online players orienting street players to specific features of the streets (phone boxes, railings, buildings, etc.), that collaborations ensue and are directed towards finding postcards for the online players, that such collaborations lead street players off track and require the intervention of Uncle Roy, and so on.

We can also see that what online players hear from street players, as conveyed to them by the contents of audio files, does not represent all of what is said by street players. The bold typing in Figure 4 represents the contents of audio files (italic text represents text messages and clues) and from this we can see that such things as requests for directions or for particular actions to be done (such as texting the name of someone from your past who never leaves you) are not heard. This may impact upon interaction and in part account for the breakdown of interaction between players (which was not an uncommon event). We can also see that not all 'utterances' are treated as relevant by street players to situated action on the streets. For example, Patrick's actions do not turn upon Nicole's utterances 24, 31, 38, 42. This is not to say that Patrick does not see them but that they are not relevant to or responded to in Patrick's ongoing interactions 'here and now' on the streets. Neither is it to say that these utterances have no part in playing the game – while Patrick does not respond to them, some of them they are important to gameplay, with utterances 38 and 42 triggering a response from Uncle Roy where the information needed to guide Patrick to Uncle Roy's office is furnished to Nicole.

Figure 4. Adding and synchronizing video content.

The assembled record reveals that interaction on the streets is not driven by each and every utterance made by players online but is instead shaped by the *exigencies of the situation on the ground*, and it is in this respect that the assembled record as it stands in Figure 4 is troublesome. Organizing content in terms of system time, the system record, which has been the basis of the assembled record to this point, offers a seductive representation of the sequential order of interaction involved in the situated production of collaborative activity. Understanding the sequential orderliness of interaction – the ways in which interaction naturally unfolds and is locally organized by participants as it unfolds - is central to the kind of ethnography pursued here and which is widely practiced in CSCW and HCI. In this respect it is critical to understand that when fragments of social interaction enter the interactional situation is *not the same* as when they are recorded by the system.

System time and interactional time are *different*, fundamentally so: one is driven by the measurable linear progression of some standard unit (cesium resonance, for example) whereas the other is driven by the exigencies of practical action and this has serious

ramifications for the way in which interaction is understood. Consider, for example, an attempt to understand the use of text messaging with mobile phones: when a message is sent and recorded by the system is not necessarily the same time as when it is read and *acted upon* by the recipient. There is, of course, bound to be a difference in send/receive times but the difference between the recorded order of events and the interactional order of events consists of more than the sequential order of time and cannot be reduced to the irremediable fact that events naturally follow on from one another. Of course they do, but the question is when? At what point in time do events follow one another? The recipient of the text message may not reply and otherwise act upon the message until some time after they have received it, hours or days even. The recorded order reifies interactional order then, representing social interaction in terms of system time but not *action time*, and so stands in our way of developing a real world, real time understanding of interaction in emerging digital environments and indeed in any other setting where system recordings are relied upon.

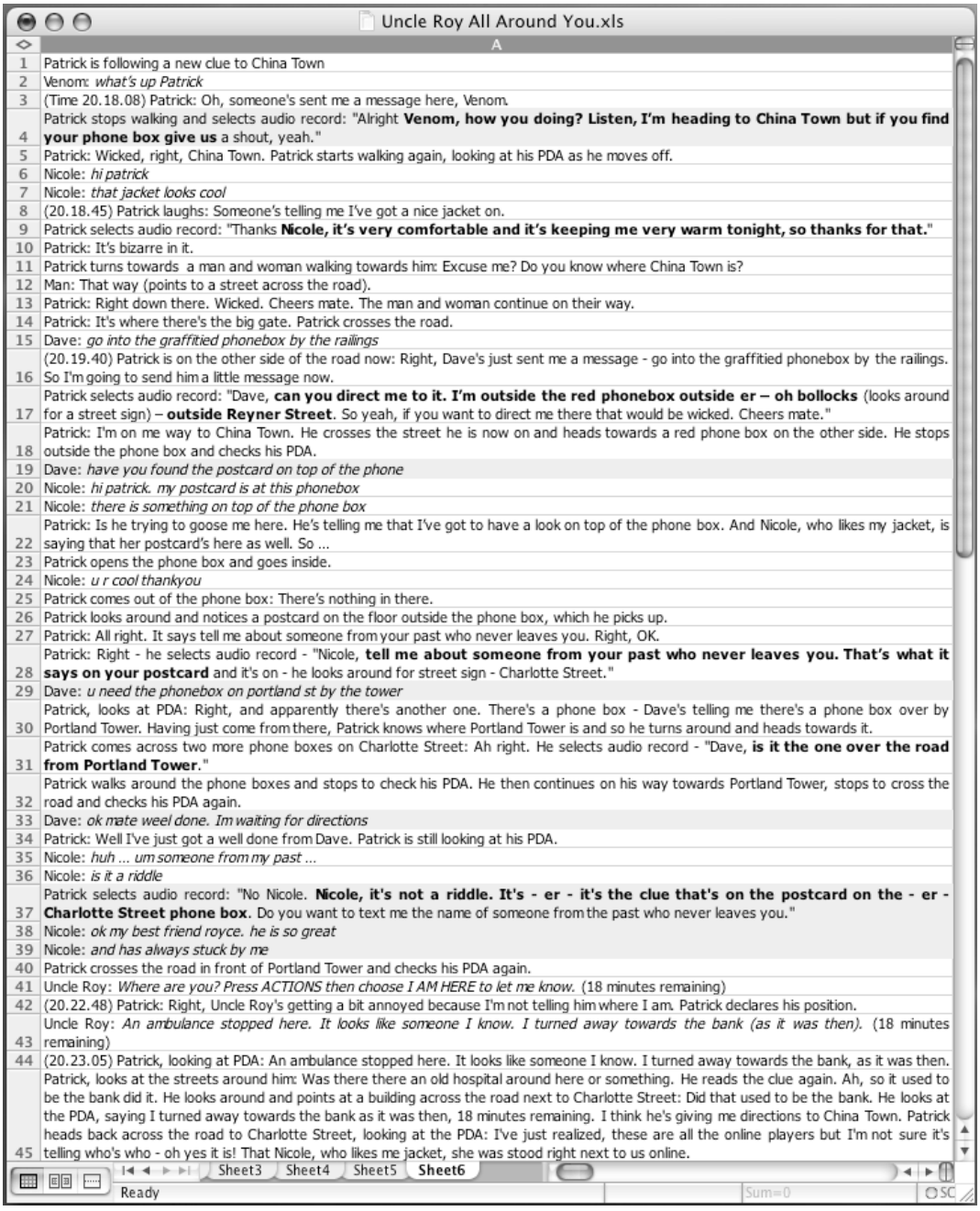

Figure 5. Difference (highlighted) between recorded order and interactional order.

Figure 5 shows the relative positions of events when organized in terms of their observable and reportable entry into the interactional situation as articulated by the street player, witnessed by the ethnographer, and recorded on video. The *re-ordering* of recorded events to reflect interactional order has a profound effect on the representation and subsequent analysis of social interaction, with online players utterances finding a new place, sense and purchase that articulates the interactional situation. For example, the highlighted utterances in Figure 5 (utterances 4, 19, 29, 33, 37, 38, 39) show the movement of log entries from linear entries in Figure 4 to interactional entries where they initiate and respond to specific actions. This representation is not to suggest that events were logged incorrectly, but that they did not become *naturally accountable features of interaction* (Garfinkel 1967) until their occurrence in the places they occupy in the interactional order of events.

Representations of the interactional order of social interaction enable ethnographers to identify users' work-practices in analysis (Button and Harper 1996). Figure 5 makes the work-practices implicated in finding a postcard available, for example. Thus we can see that finding a postcard intersects and overlaps with the work of following clues and that both are done by exploiting local knowledge, either that of passers by or that gathered in the process of navigating the physical game space, to interpret messages and clues. Furthermore, this representation makes it clear that online and street players coordinate the search for postcards by issuing instructions and clarifications, which are essentially 'ecological' in character. In all their variations they revolve around formulating adequate directions to places and objects, and coordinates locating places and objects. Thus, and for example, Dave instructs Patrick to "got to the graffitied phone box by the railings" but it is not clear from Patrick's position on the streets just where the graffitied phone box is and he formulates a clarification framed in terms of his immediate ecological relevancies – i.e., in terms of his current physical location and what to look out for from here: "Can you direct me to it? I'm outside the red phone box outside Reyner Street", which Dave responds to by saying, "You need the phone box on Portland Street by the tower." While online players track street players through a virtual facsimile of the street player's physical ecology the two parties do not share the same orientation to places and objects. Successful collaboration relies then upon the players' ability to establish a *mutually intelligible orientation* to places and objects. Instructions are not sufficient in themselves to establish this, however, as they lack ecological validity and cannot do otherwise given the asymmetry between the players' ecologies. The ecological validity of instructions is practically resolved, and mutually intelligible orientations achieved, through clarifications framed in terms of ecological relevancies, the identification of candidate places and objects, and the subsequent reformulation of instructions furnishing coordinates that align street players and online players orientations and permit productive interaction (Crabtree and Rodden 2006).

Supporting the Assembly of Digital Records

While exploiting an array of digital media (spreadsheets, video and audio tools, etc.), the work we have presented above is essentially manual in nature. Extraction, synchronization, and representation are done by hand as it were. A core feature of our research is to develop a range of tools to support the work of reconciliation involved in the assembly of digital records. In this section we present a brief overview of the first iteration of a suite of computational mechanisms to support this work, generically referred to as the *Replay Tool*.[3]

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3 For a more comprehensive overview of Replay Tool see French et al. *Software Replay Tools for Time-based Social Science Data* in these proceedings.

Extraction

System recordings may be vast. *Uncle Roy All Around You* runs live for periods of up to two weeks at a time and every system-based event over that time is recorded, for example. The materials gathered by the ethnographer are much more finite and bounded. In the context of technological studies he or she usually conducts fieldwork for relatively short periods of time (Hughes et al. 1994), a day here, a day there, and gathers materials from out of the flow of interactions between particular participants rather than everybody in order to explicate the 'social machinery' organizing interaction (Benson and Hughes 1991). Accordingly we have developed a tool called Data Goggles (Figure 6), which enables the ethnographer to gain an overview of all the materials comprising the ethnographic record and to extract materials relevant to the fieldwork.

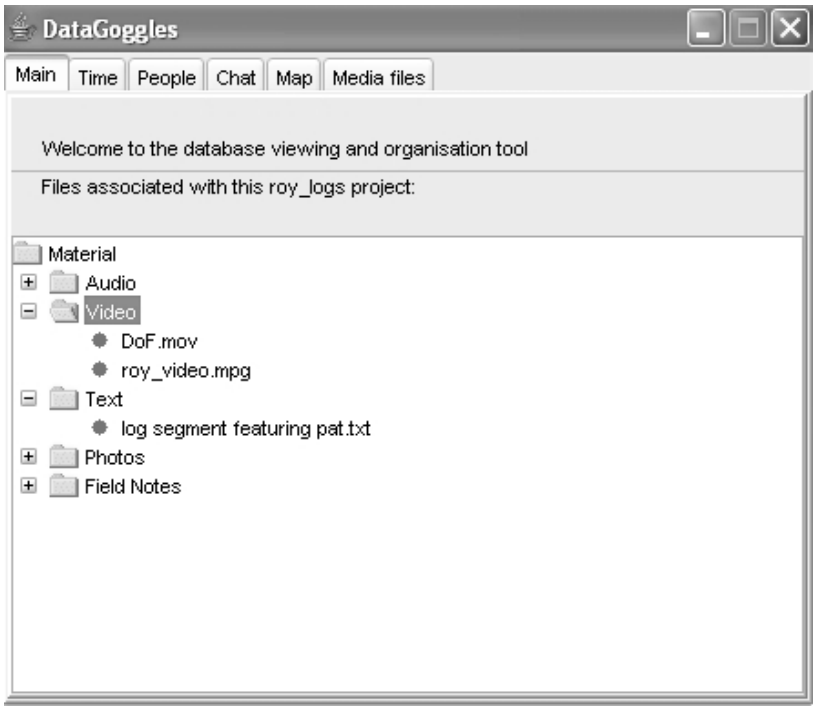

Figure 6. Data Goggles.

This tool provides a range of functionality. Most notably it allows the ethnography to specify relevant time frames, participants and media (e.g., text and audio) so that materials relating to those times and those people may be extracted from system recordings. Insofar as location-based technologies are implicated in interaction, Data Goggles also provides map visualizations of mobile participants movements through the streets. In time, this too may become a way of extracting relevant material from system recordings, with fieldwork materials being organized around participant's movements.

Synchronization

Once the ethnographer has specified what materials he or she wishes to extract from the system recordings they are imported into the Replay Tool itself (Figure 7). Notably, Replay Tool also imports external resources and allows selected system recordings and, in this case, video to be *replayed* alongside each other. Replay Tool aligns selected system recordings with external resources such that as the video is played the system recording is automatically scrolled through. The temporal relationship between the video and the content of selected system recordings is displayed through the use of (dark) colour highlights. Other internal

resources, such as audio files, are made available via hyperlinks embedded in the system recording. When selected these are imported into a standard media player (as is the video) and may also be played alongside the video and system recording.

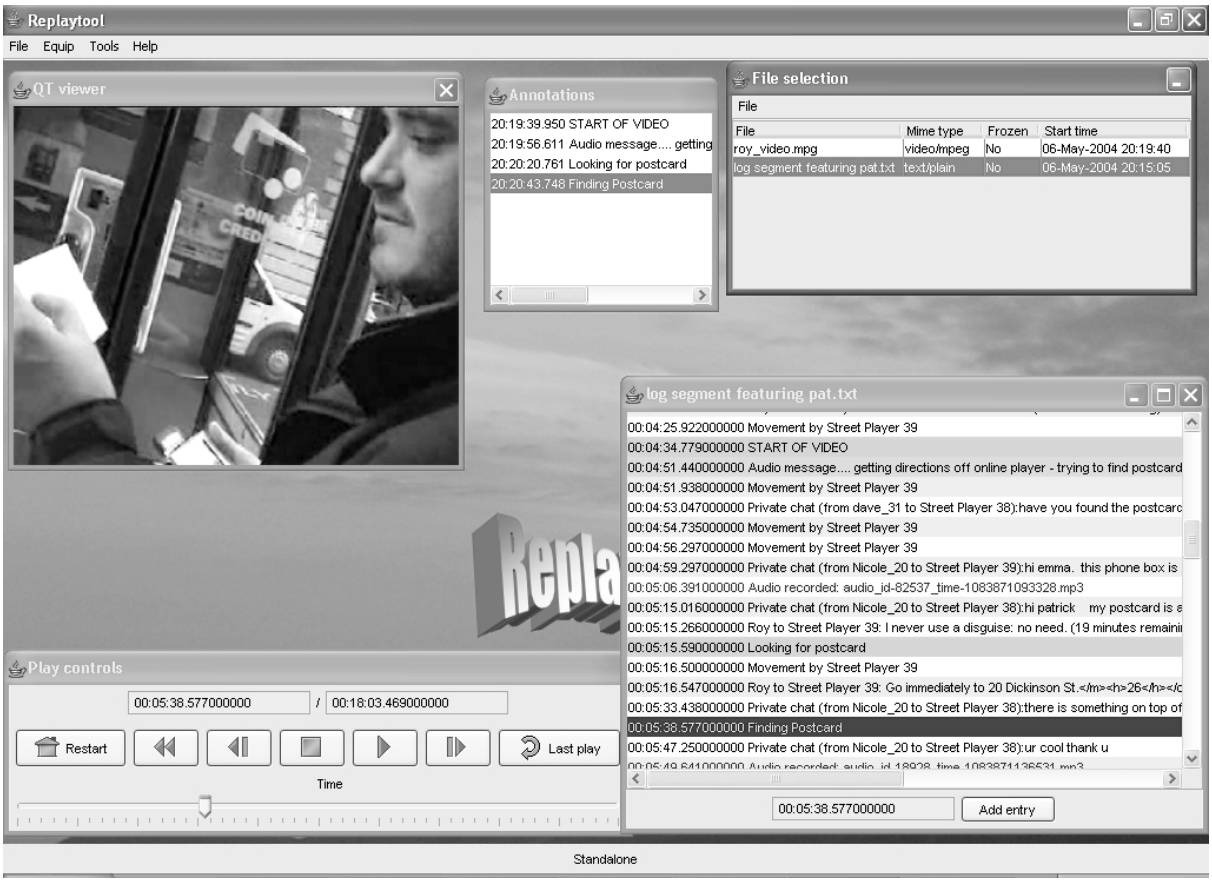

Figure 7. The Replay Tool.

Replay functionality enables the ethnographer to inspect and examine all relevant material he or she has gathered in a synchronous fashion. In order to develop a coherent representation of interaction is necessary that relevant materials be synchronized to an even greater extent, however.

Representation

Replay Tool also provides functionality for the ethnographer to add transcriptions and other descriptions of action and collaboration to the system recording through annotation. Annotations are inserted into the system recording itself and also made available in a separate interface, which serves as an index to the digital record. This index allows the ethnographer to mark out significant sequences and features of interaction (such as finding a postcard or any other significant event) as he or she works through the fieldwork material (Figure 8). Replay Tool also enables the ethnographer to delete non-relevant features of the system recording and to re-order recorded entries by moving them to new locations in the recording. Over time, annotation allows the ethnographer to work up thick descriptions and coherent representations of interaction then, which not only situate internal and external resources side-by-side but situate them in the *places that they occupy within the interactional order of events*. Furthermore, constructed representations may be replayed along with all the materials they are composed of, a function the supports presentation and collaborative analysis.

Figure 8. Working up a representation of interactional order.

Replay Tool also enables representations of interaction to be constructed for analysis whilst preserving the original system records. When creating a digital record of interaction the ethnographer is essentially creating a new version of the underlying system record. This means that the original data set may be recovered at any time in the future to inspection, examination and analysis in a different vein (one might consider text mining, for example) by others.

Conclusion

The current iteration of Replay Tool handles only free-text annotation, as to date that is the main facility required for the ethnographers we are working with. We recognize that other forms of ethnography exist and future work seeks to extend functionality to support more conventional forms of analysis. Accordingly, we are currently developing functionality to enable analysts to construct and use coding schemes within Replay Tool to allow for more structured types of analysis. Structured annotation and meta data will be supported using the World Wide Web Consortium's Resource Description Framework (RDF) using a number of interlinked Web Ontology Language (OWL) ontologies.[4] We are also developing a web version of Replay Tool that will cache system recordings, media files, annotations and meta data locally on the user's machine so as to assure performance and enable offline use. Assembled records may subsequently be uploaded to an online repository to provide a central resource of data available to the members of different research groups. The plan is to release Replay Tool to social science researchers via sourcforge.net later in the year. Obviously issues with data access and security are relevant here and options are currently being explored to ensure the integrity of the process.

4 See www.w3.org/RDF and www.w3.org/2004/OWL respectively.

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References

Barkhuus, L. et al. (2005) "Picking pockets on the lawn: the development of tactics and strategies in a mobile game", *Proceedings of UbiComp '05*, pp. 358-374, Tokyo: Springer.

Benford, S. et al. (2003) "Coping with uncertainty in a location-based game", *IEEE Pervasive Computing*, vol. 2 (3), pp. 34-41.

Benford, S. et al. (2004) "The error of our ways: the experience of self-reported position in a location-based game", *Proceedings of UbiComp '04*, pp. 70-87, Nottingham: Springer.

Benson, D. and Hughes, J.A (1991) "Method: evidence and inference", *Ethnomethodology and the Human Sciences* (ed. Button, G.), pp. 109-136, Cambridge: CUP.

Brown, B. et al. (2003) "Lessons from the lighthouse: Collaboration in a shared mixed reality system", *Proceedings of CHI '03*, pp. 577-585, Ft. Lauderdale, Florida: ACM.

Button, G. and Harper, R. (1996) "The relevance of 'work-practice' for design", *Journal of CSCW*, vol. 4 (4), pp. 263-280.

Crabtree, A. et al. (2000) "Ethnomethodologically informed ethnography and information systems design", *Journal of American Society for Information Science*, 51 (7), 666-682.

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

Crabtree, A. (2004) "Design in the absence of practice: breaching experiments", *Proceedings of DIS '04*, pp. 59-68, Cambridge, Massachusetts: ACM Press.

Crabtree, A. and Rouncefield, M. (2005) "Working with text logs", *Proceedings of the 1st International e-Social Science Conference*, June 22-24, Manchester: ESRC.

Crabtree, A. et al. (2006a) "Developing digital records: early experiences of record and replay", to appear in *Journal of CSCW*, Special Issue on e-Research.

Crabtree, A. et al. (2006b) "Supporting ethnographic studies of ubiquitous computing in the wild", to appear in *Proceedings of DIS '06*, June 26-28, Penn State, Pennsylvania: ACM.

Crabtree, A. and Rodden, T. (2006) "Hybrid ecologies: understanding cooperative interaction in emerging physical-digital environments", submitted to *CSCW '06*, Banff: ACM.

Garfinkel, H. (1967) *Studies in Ethnomethodology*, Englewood Cliffs: Prentice-Hall.

Geertz, C. (1973) "Thick description: toward an interpretive theory of culture", *The Interpretation of Cultures*, pp. 3-30, New York: Basic Books.

Hine, C. (1998) *Virtual Ethnography*, London: Sage.

Hughes, J. et al. (1994) "Moving out of the control room: ethnography in systems design", *Proceedings of CSCW '94*, pp. 429-438, Chapel Hill, North Carolina: ACM.

Lynch, M. (1993) "From quiditty to haecceity", *Scientific Practice and Ordinary Action*, pp. 265-308, Cambridge: CUP.

Ryle, G. (1971) "The thinking of thoughts", *University Lectures No. 18*, University of Saskatchewan: Canada.

Sacks, H., Schegloff, E., and Jefferson, G. (1974) "A simplest systematics for the organization of turn-taking in conversation", *Language*, vol. 50, pp. 696-735.

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