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Integrating New Technologies into Established Systems: a case study from Roman Silchester

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Abstract

Introducing new ways of working into well established systems can be problematic, especially if the change involves the introduction of unfamiliar technology. This paper focuses on the adoption of digital field recording systems at the Roman site of Silchester and explores how the implementation of new technology has impacted on the workflow of the site. The University of Reading's excavation of approximately one-third of Insula IX began in 1997 and last summer saw the completion of the twelfth field season. The challenge of successfully integrating new technologies into an existing well developed and long established excavation recording system provides an ideal case study for change management in archaeology.

Fieldwork observations, user needs discussions and formal written questionnaires at the Silchester excavation have shown that whilst the technology itself was robust and easy to use, issues arose around its implementation. Issues encountered included: staff involvement and commitment, staff and student training, workflow difficulties, the central role of the traditional context card, and problems associated with hybrid systems. The issues encountered at Silchester are by no means unique to the project and we endeavour to draw out some of the themes that we feel can be more widely applied to change management in ICT-enabled projects.

***Key words**: User Analysis, Human Computer Interaction, User Needs, Change Management, Field Recording*

1 Introduction

The **V**irtual **R**esearch **E**nvironment for **A**rchaeology[1] (VERA) project investigated the use of information technology (IT) by archaeologists in the context of field excavations and associated research. The project aimed to produce a fully operational virtual research environment for the archaeological community. This paper presents the results of user needs analysis undertaken as part of the VERA project and addresses the wider issue of change management in ICT-enabled projects.

Our study is based around an established excavation of part of the large Roman town at Silchester[2], which aims to trace the site's development from its origins before the Roman Conquest to its abandonment in the fifth century A.D[3] This large scale, long term excavation is run by the University of Reading's Department of

1 http://vera.rdg.ac.uk/

2 http://www.silchester.rdg.ac.uk/

3 Clarke, Amanda et al., "Silchester Roman Town Insula IX: The Development of an Urban Property c. AD 40-50 - c. AD 250," Internet Archaeology 21 (2009),http://intarch.ac.uk/journal/issue21/silchester_index.html.

Archaeology[4], and is used as a compulsory, hands-on training component of their undergraduate archaeology degree. The rich and complex finds from the excavation have been logged, for the past decade, in the Integrated Archaeological Data Base (IADB[5]), an online database system for managing all aspects of recording, analysis, archiving and online publication of archaeological excavations. Students at the field school learn both about practise based archaeology, and how information technology can aid archaeologists with their complex recording requirements. Roman Silchester therefore provides usability experts with a site to investigate the use of advanced Information Technology in an archaeological context.

The VERA project, funded by the Joint Information Systems Committee (JISC) Virtual Research Environments Programme (Phase 2) and running from April 2007 until March 2009, was undertaken by researchers at the School of Library, Archive and Information Studies (now the Department of Information Studies[6]), University College London, in collaboration with the School of Systems Engineering[7], and the Department of Archaeology, University of Reading, and York Archaeological Trust[8]. The project investigated the tasks carried out within archaeological excavations – focussing on the Silchester dig as a case study – to ascertain how and where technology can be used to facilitate information flow within a dig, and to inform the designers of computational tools such as the IADB how the interface and environment may be adapted to allow integrated use of the tools in the trench itself.

4 http://www.reading.ac.uk/Archaeology/

5 http://www.iadb.org.uk/index.htm

6 http://www.infostudies.ucl.ac.uk/

7 http://www.reading.ac.uk/sse/

8 http://www.yorkarchaeology.co.uk/

This paper focuses on one particular aspect of the VERA project, the adoption of digital pens for on site context recording at Roman Silchester. In it we describe some of the work carried out on the user needs side of the project and we highlight some of the themes that we think can be applied more widely to change management in ICT-enabled projects.

2 Research Overview

Digital field recording and born digital data are often vaunted as the future of archaeological practice and identified as a prerequisite in a brave new world where "information flows seamlessly from excavation, through post-excavation to publication and archive"[9] There has perhaps been an underlying assumption that 'digital' necessarily means 'better' or 'faster' but the adoption of new technologies is not something that should be undertaken lightly or without careful research and preparation. Introducing new ways of working into well established systems can be problematic, especially if the changes include the introduction of unfamiliar technology.

"Publication after publication reaches the same conclusion: that technology is important but insufficient on its own for the success of ICT-enabled projects. Again and again technology projects fall down not because the hardware is unstable, but because different systems' architectures have been poorly scoped and designed. Without good change management and careful thought given to the people using the systems as well as the technology itself, ICT-enabled projects are unlikely to be successful…"[10]

9 Lock, Gary. *Using Computers in Archaeology*. (London: Routledge 2003), 265.

10 Jones, Alexandra and Laura Williams *How ICT? – managing at the frontline* (London: Work Foundation,

The VERA project aimed to investigate the use of IT within the context of a field excavation and to ascertain whether it may be appropriated to speed up the process of data recording, entry and access[11]. The Silchester excavation covers some 3025 square metres and from its outset digital technologies, in the form of the IADB, have been key to managing the vast amount of data involved in this large project. A key concern of the site directors has been how to speed up the transfer of information from trowel to database and since 2007 digital pens and paper have been trialled for direct digital data gathering. The pens were initially chosen because they are relatively cheap to buy and because they appeared to offer a 'high-tech' development of something which, from the users point of view, is reassuringly familiar and 'low tech'.

In common with the majority of complex urban archaeological sites excavated in the UK, Silchester uses single context planning to record the site and data is recorded using context recording sheets (CRS). The recorded data must then be transferred from the CRS to the IADB and in the past the entry of data on to the IADB has been undertaken manually. With more than 1000 contexts recorded each season at Silchester, manual input of the data and information has been very time consuming and typically took place after the excavation season had finished. This has meant that in the past the specialists involved with the excavation have often had to wait several months to be able to access the most recent information about newly excavated contexts. It has also meant that during the excavation season the site staff have to search through the paper records to access any information that they require.

Hodder[12] has argued that the use of complex databases post-excavation can impose a highly codified process of data gathering on excavations, where interpretation is separate from the acquisition of data. Ideally the adoption of new technologies on site should create a situation where the use of IT allows data to be interpreted using IT soon after acquisition and the results of this fed back to the excavators to further aid their work[13]. Previous experiments at Silchester with manually digitising CRS and plans on site were abandoned because supervisors did not want the CRS to be taken away from them because they needed to be able to access the information on them and continued to make amendments to 'completed' CRS through the season. The digital pens offered the possibility of onsite digitisation without the disadvantages of manually entering the data. Daily uploading of the pens would allow the IADB to be kept up to date throughout the excavation and the information to made readily available to both those working onsite and associated specialists working remotely.

The digital paper used with the digital pens can be printed to look like a traditional CRS but this route was not taken at Silchester for a number of reasons. First, the CRS used at Silchester are slightly modified each season and so are only

2005), http://www.theworkfoundation.com/assets/docs/publications/46_How ICT managing at the frontline.pdf (accessed May 28, 2009).

[11] Warwick,Claire et al, "iTrench: A Study of the use of IT in field archaeology," *Literary and Linguistic Computing* 24, no. 2 (2009): 211-24.

[12] Hodder, Ian "Always momentary, fluid and flexible': towards a reflexive excavation methodology." *Antiquity* 71, no. 273 (1997): 691–700.

[13] Beck, Anthony and Maria Beck, "Computing, theory and practice: establishing the agenda in contract archaeology," in *Interpreting Stratigraphy: Papers Presented to the Interpreting Stratigraphy Conferences 1993–1997*, edited by Roskams, Steve, (Oxford: Archaeopress 2000) 173–181.

required in limited print-runs, which makes the cost prohibitively expensive. Secondly, pre-printed digital forms are designed to be filled in in order, a practice most uncommon in field archaeology. Whilst it is fairly inexpensive to buy the 'off-the-shelf' digital notebooks they look like an ordinary lined notebook, rather than a CRS and users must enter context data as a series of key/value pairs which can then be parsed into the IADB.

During the 2007 field season initial scepticism about the digital pens meant that they were used to record contexts that were also recorded using a traditional CRS but for the 2008 field season the pens were used throughout the trench in place of their traditional counterpart. Contexts recorded using the digital pens and notebooks were checked by supervisors, as with the traditional CRS, and then uploaded, onsite, to the IADB by the VERA-funded research assistant.

The process of uploading the pen data to the IADB involves a number of stages. The software provided with the pen is used to download the raw "ink" data from the pen via a USB connection. An optical character recognition module within the software is then used to generate an XML format file containing the recognised text.. Recognition errors are checked and corrected at this stage. The XML file is uploaded to the IADB which parses the data into context records and fields. After final checking and correction, the parsed data is saved to the IADB project database.

After uploading the records were then printed out and passed back to the supervisor to check and amend as necessary. Any amendments were noted on the printed version of the CRS and then passed back to the research assistant who made any necessary changes to the IADB.

Whilst archaeologists have made efforts to use technology to integrate excavation recording and interpretation since the late 1990s (Andrews *et al* 2000) full integration remains difficult to achieve, even with the most up to date technology. We wished to study how digital pens can be introduced into the field archaeologist's range of tools and whether they can speed up information capture, and integration of that information into a wider research environment[14].

3 Methodology

In order to better understand user reactions to the use of digital pens during the 2008 field season at Silchester a mixture of fieldwork observation and user needs discussions were used alongside a more formal diary study[15] and end of season written questionnaire. The primary aim was to discover how well the digital pens fitted in to the workflow of the site and to record user feedback about their use. Although the digital pens had been used during the 2007 field season at Silchester they had only been used in a limited area of the site and VERA staffing issues meant that there had been no formal evaluation of how well they had fitted into the site's workflow. The research described here was carried out by an

14 The adoption of the digital pens for context recording during 2008 meant that 587 CRS (43%) were digitised during the season. Clarke and O'Riordan (this volume) estimate that this would have taken 147 hours, or nearly 20 full days of post-excavation time. The VERA-funded research assistant who uploaded the pen data was employed full-time throughout the season and spent (at least) this amount of time on site dealing with context data from the digital pens. It is debatable then whether the increase in the amount of on-site digitisation can be attributed to the use of the digital pens or simply to the extra man-hours invested in the uploading of data.

15 Warwick, Claire et al, "iTrench: A Study of the use of IT in field archaeology," *Literary and Linguistic Computing* 24, no. 2 (2009): 211-24.

embedded researcher during three weeks of the Silchester 2008 field season 2008 (weeks 1, 3 and 6) in the hope of achieving an overview of the entire season.

A diary study carried out during the 2007 field season at Silchester had suggested that some of the resistance to the use of digital recording on site stemmed from the suspicion that conditions on site were just too hostile for digital hardware[16].

"I think that a computerised version of our paper records is a good idea, but I feel that the environment that I work in doesn't really suit an electronic/computerised source. We work in muddy and wet conditions and expensive equipment may well be ruined."

(P17[17], 2007 Diary Study)

The 2008 diaries, completed by 28 participants, did not show the same concerns about the robustness of the new technology but field observations and questionnaires did show that these concerns were still very much in the minds of the users. Initial field observations in 2008 suggested that whilst the digital pens are, in theory, fairly simple to use they were causing some difficulties for the members of staff who had to supervise the records created using them. In order to explore this issue user needs discussions focused on the experience of those supervising the use of the pens but also included discussions with members of staff who were less involved in supervising the digital recording system and students. Formal user needs discussions were recorded in either audio or video formats, depending on the preference of the interviewee, and all discussions were transcribed to provide accurate quotations. The discussions provided the framework for creating the end of season review for the digital pens. This end of season review was completed by fifteen members of staff, representing a cross-section of responsibilities; supervisors, assistant supervisors and experienced site assistants.

4 User Perceptions

Archaeological excavations usually operate on tight, limited budgets and archaeologists are understandably concerned that new and relatively costly equipment will be fit for purpose. The use of digital technology in the field is especially challenging, because of the hostile environment. As Backhouse (2006) explains:

"It is a well known truism that any equipment that goes to site ends up broken. Digital cameras are dropped in buckets of water, mobile phones are buried in trial trenches, EDMs fall off cliffs. Archaeologists, it seems, cannot be trusted with equipments that use batteries without breaking something—electronic casualty rates in the field are very high."

Although the digital pens had survived the 2007 season the question most commonly raised by new users in 2008 was how robust were the pens and what were their operating parameters.

"But I don't like having something on site that you don't feel you can bounce around."

(P15, 2008 User Discussions)

"And just also to let people know how much abuse we can give the pens I think, how far we can push them before they'll break."

(P15, 2008 User Discussions)

[16] Warwick, Claire et al, "iTrench: A Study of the use of IT in field archaeology," *Literary and Linguistic Computing* 24, no. 2 (2009): 211-24.

[17] P17 refers to participant number.

"I think that the reason that the digital pens aren't very good is that I honestly don't think you could drop one in there (muddy, waterlogged feature) and it would still work very well. Also the large amount of water around."

(P19, 2008 User Discussions)

Many of the supervisors and assistant supervisors employed by the field school have experience of working for commercial archaeology units and some users were unconvinced that the pens would operate in a commercial environment where excavation takes place throughout the year and in far harsher conditions than at the Silchester field school.

"Other problems that I think might be encountered is if they'll stand up to the rigours of commercial archaeology."

(P18, 2008 User Discussions)

Whilst it was desirable that users should treat the digital pens with a reasonable degree of care it was also important that the digital pens be tested in circumstances that might normally occur on an archaeological excavation. To provide a true test of the digital pens, users were encouraged to use the pens and notebooks in any situation in which they would normally expect to complete a paper CRS; e.g. traditional context recording sheets need to be protected in wet weather. Field observations did show, however, that users tended to treat the digital pens and notebooks with more care than their usual biros and paper CRS.

One of the advantages of having members of the VERA team on site for the 2008 field season was that we were able to respond to user questions by carrying out field tests to explore the robustness of the digital pens and notebooks. A number of likely scenarios were staged: e.g. exposing a digital notebook to rain and then drying it before trying to write on the now wavy pages; writing in a notebook that had been marked by muddy boots and a cup of tea. The tests proved the pens and notebooks to be remarkably robust and tolerant of typical site accidents and this went some way to convincing users that they wouldn't fall apart in their hands.

5 Supervisor Support

The size of the Silchester field school means that the site directors must rely on a large team of staff to support them throughout the season. Site supervisors and their assistants are key to the smooth running of the excavation and each supervisor takes charge of an area of the site and the students assigned to the area. The enthusiasm and confidence of the supervisors for the new recording system played a huge role in how their teams reacted to the digital pens. Interestingly one interviewee suggested that negative reactions during the 2007 field season had reflected staff scepticism filtering down to students.

"Yeah, I think part of the problem last year was that it was only rolled out in a small area – none of us, the rest of us, even saw them, and I think people in the south-east I think – from what I heard, they weren't massively receptive to the new technology and things, they were very anti it, I think because the staff were anti it, the students were anti it, and it just filtered down and we wouldn't hear anything about them except you know what they were saying about them, so…"

(P9, 2008 User Discussions)

The Silchester field school trains over 100 people a week and many of the students attending have little or no experience of field archaeology. As a result students tend to take their lead from the more experienced people around them; if these experienced people are seen to be reacting negatively to new technologies, as seems to have been the case in 2007, then it is unsurprising that

their negativity influences the inexperienced students. During the 2008 field season the trench was split into five areas, each with its own team of staff. The enthusiasm/support of individual staff members for digital recording obviously influenced the amount of time and effort that they were inclined to give to digital recording. Staff who were personally interested and in favour of digital recording spent time learning about the possibilities of the technology and then passed on their knowledge and enthusiasm to their team. As one participant pointed out motivating new students to use the digital pens should not be an issue if they are told that that is the Silchester recording system.

"Um, I think motivating…. For students it's wasn't that hard, because they don't know there's ever a different method of doing it – I mean, me and XXXXX really like them, so it was easy to motivate other people because we were really enthused about them ourselves, we were like 'look, look how easy it is, look how easy it is' you know."

(P9, 2008 User Discussions)

Although there was a lot of interest from site staff to see how digital recording might work for field archaeology, particularly if it could reduce the amount of time spent undertaking tedious data entry, not all of them had the confidence necessary to inspire the rest of their team. One of the supervisors who was particularly negative about the digital pens said that they found it hard to teach students to use the pens when they didn't have a clear idea in their own head of how to use them. The key point here is how important it is that supervisors and other staff are confident enough about digital recording to be able to teach the rest of their team. If the 'teachers' don't have confidence in and enthusiasm for the new system/technology then it is unlikely that they will be able to inspire other people to work through the early teething problems that come with any new system.

Towards the end of the season staff were asked to complete an end of season review/questionnaire about their experience of using and supervising the digital pens. The questions asked in the questionnaire all came out of discussions that had taken place over the season. Answers showed that many of the staff would have liked to have gained some practical experience of using the digital pens before the excavation started and that some staff felt that they would have benefited from having a better understanding of the system before they were expected to teach other people.

"A full training session on how to use them before being expected to teach other people. Going through the full process of how they're downloaded etc and put on the database would have been useful for a better understanding."

(P5, 2008 End of Season Review

"Would have liked opportunity to see/use before trying to train students to use them."

(P9, 2008 End of Season Review)

In theory the digital pens are fairly easy to use, but as one participant pointed out it is the practicalities and issues surrounding their use in the field that worried a lot of people.

"Using the pens is fairly easy, in theory, it's the practicalities and issues surrounding the use in the field that worry a lot of people. So info on tolerances and what to do if you make mistakes would have helped."

(P15, 2008 End of Season Review)

Some of the supervisors were more proactive about learning about the new recording system and if they found themselves lacking in knowledge or experience they were prepared to

ask questions. This is an ideal situation to be in, to have an eager and willing team championing the new technology, but it does rely on the appropriate teaching and support being readily available for these people. A willing workforce can quickly become disillusioned if they don't have a supportive and well-informed team of mentors on hand to offer support. There also needs to be a balance where staff are encouraged to ask questions and give feedback but where they don't feel that they are having to make all the effort themselves. Ideally there will be a situation where the questions and issues raised on site in one season are used to improve the teaching and support next time for the next season.

Whilst staff enthusiasm was hugely important in motivating the rest of their team the VERA team needed to play their own role in motivating the Silchester staff. It is vital that the field staff are provided with the skills to be able to teach other people how to use the new technology. The 2007 field season had apparently created some negative feelings towards the VERA project and so it was especially important to try to counter any of this existing negativity early on in the 2008 field season. The easiest way to build support for a project is to make staff feel that they are involved. In the case of Silchester this meant making staff feel involved in the process of developing a new recording system and suggesting that changes could benefit both the Silchester site and also the wider archaeological community.

6 Teaching the Workforce

On site teaching is a major part of the Silchester Field School and participants receive teaching in both formal (scheduled talks) and informal situations (ad hoc on site teaching) from the project team, supervisors and assistant supervisors. There is also a certain amount of peer-to-peer teaching as more experienced students share their expertise. The 2007 diary study had showed that some people felt that the new technology being used on site was insufficiently explained. As a result of feedback from the 2007 season it was agreed that it would be useful to run a training session in the use of ICT hardware before the start of the 2008, in addition to the usual archaeological training. This was to be supplemented by onsite situational training and supported by onsite technological help.

Discussions with supervisors showed that the issue of supervising the use of the digital pens and notebooks had not been thoroughly explored with them before the season started and that as there was no suggested supervisory strategy supervisors were left to design and implement their own working practices. This obviously caused some difficulties as supervisors were expected to "hit the ground running". Opinion appears to have been divided over whether it was best to offer people the option of using the digital pens or whether it was better simply to tell them that was the recording system.

Compare

"Like I've always said to them if they're really unhappy with it then I'm not going to make them do it, as long as they've all had a go."

(P2, 2008 User Discussions)

With

"as I say, we didn't give them much of an option! I heard some of the other supervisors 'oh please would you do a digicontext' and we were like 'don't ask them, tell them!' it's the system!"

(P9, 2008 User Discussions)

"I think that's was the big difference – I think other groups weren't introducing it straight away to their students, they weren't saying 'this is the system'."

(P9, 2008 User Discussions)

This difference in approach is perhaps a legacy of the 2007 season which convinced some that a heavy-handed approach might result in a negative response. User discussions showed that there was general agreement amongst supervisors and assistant supervisors that introducing new students to the digital recording system straight away was the best approach because most of them had no previous experience of context recording. It will be interesting to compare the different ways in which the different groups approached the matter of supervision and hopefully it will be possible to draw out examples of best practice for the future.

"I know I started teaching to most of the new people using the new stuff and I think they're finding it a lot easier than me! I think I'm just adapting a bit slower."

(P15, 2008 User Discussions)

"I think it's really good this season that we've started introducing new people straight to them."

(P15, 2008 User Discussions)

"Most people were quite willing to use them, because I told them we were using them and not paper contexts anyway and most of mine were new, so it was easy."

(P20, 2008 User Discussions)

Once again it is obvious that staff experience and confidence is key to them being able to teach other people how to use the technology.

"I think if the actual staff themselves are prepped in how to use the technology it's the best way to do it…"

(P22, 2008 User Discussions)

As well as there being a lack of coherence in the policy of teaching students not all members of staff appeared to have received training in how to use the digital pens and notebooks or how to teach others how to use them. When one student participant noted that in their group the backs of pages were frequently left blank another student in the same group reported that this was what they had been told to do by a junior member of staff.

"I think it might have helped to have had more training in how they work at the beginning, cos some people didn't write on the back of the pages for ages!"

(P24, 2008 User Discussions)

The Silchester field school is a vast undertaking and junior staff are not always there for the whole season making it difficult to ensure that all staff are fully briefed. A guide to using the digital pens was included in the 2008 handbook but field observations indicated that very few people actually knew this. One student participant suggested that the guide should be included at the front of the notebook.

"In the book maybe, in the front, you could have a sheet on how to fill it out maybe?"

(P24, 2008 User Discussions)

Currently students are required to attend a number of compulsory talks in which they learn about various aspects of archaeological fieldwork. One of the talks is an introduction to the Silchester recording system and it has been suggested that the digital recording system be included as part of this talk. An organised, compulsory talk for students might also take some of the pressure off supervisors and would

ensure that every body is being taught the same system.

"I think if we're gonna sort of use this again next season as "the" recording method, it should really run alongside the planning talks, and the normal context card talks."

(P9, 2008 User Discussions)

7 Digital Pen Workflow

The end of season review showed that most staff felt that teaching students to record using the digital pens and notebooks was regarded as fairly straightforward, once the staff understood the process themselves. The hardest part of supervising the use of the digital pens and notebooks was thought to be the process of checking the work of others. The paper CRS have a well-established system for checking recording but many staff found it difficult when using the digital pens and notebooks.

"So, from a checking point of view, to actually be able to go through and check it, in the actual book itself, has been quite difficult. And I've found it a lot easier to actually get a printout of what's been already done with that context so that I can actually see it."

(P2, 2008 User Discussions)

"I think the hardest part about the supervising was actually keeping track of the checking, um, you know that was…..sometimes a bit of a mission"

(P9, 2008 User Discussions)

"I think it's actually easier to use as a recording device than to check somebody else's work on it."

(P12, 2008 User Discussions)

"It just gets too complicated to go back over and go 'well have you done this context, does this context need to be redone?'"

(P15, 2008 User Discussions)

8 The Value of Familiarity

Prior to the 2008 field season at Silchester the focus had been on whether the digital pens would stand up to the rigours of use in the field and, to a lesser extent, whether people liked using them. It wasn't until we began to look more closely at the digital pen workflow and to ask people why they felt the way they did about the pens that we began to really understand how central the traditional CRS is to the day to day running of the site. This is an interesting point to pick up on because it illustrates just how much things like the CRS are taken for granted – they have become such an intrinsic part of life for so many archaeologists that it is easy to over look the key role that they play.

Many of the problems that staff experienced with checking the digital context recording were a result of the format of the digital notebooks. Unlike the traditional printed CRS the digital notebooks look just like standard lined paper without any of the boxes of headings. Staff reported that the unstructured nature of the notebooks means that students are more likely to miss things out when using the digital pens and notebooks and also less inclined to get their work checked.

"There's usually a bit more left out than on a normal context sheet."

(P8, 2008 End of Season Review)

"I think they've also been less inclined to go back and finish their context cards, because when it's a

card and it's in the ongoing box they know where to find it, they just go to it, they fill in the bits that they don't know."

(P2, 2008 User Discussions)

There was an acetate sheet of codes at the back of the notebooks which listed the appropriate field codes but it did not provide users with as many prompts as the paper CRS and field observation confirmed that many people continued to refer to the paper CRS as they filled in the digital notebooks.

"I don't like the empty notebook because on the (printed) context card if you've got a cut or a deposit or whatever it is you have prompts in the box that says number 1 = colour, number 2 = edge definition, things like that. So you don't need to remember anything, you just look at 1, 2, 3…"

(P18, 2008 User Discussions)

"But that was, that was probably the reason that it took me longer actually because I was always referring back to the old context card to see what descriptions were required."

(P18, 2008 User Discussions)

"it'd be useful to have the 1,2,3,4,5 description bit like printed on the back of the book as well,"

(P24, 2008 User Discussions)

As well as missing the help given by the extra prompts on the paper CRS, users reported that they missed having the visual prompt of actually seeing the boxes on the paper CRS. At a glance users were able to see any boxes that remained empty, allowing them to quickly check if extra information was required.

"I still think that you can get confused and you can not include stuff and you can miss stuff off more easily than you can with a context card that's the actual physical context card. It's almost like ticking boxes…"

(P15, 2008 User Discussions)

"I think the only downside has been that it's, because there's no set spaces to write the stuff in, it's easy to forget to write one of the elements in there."

(P20, 2008 User Discussions)

This concern about the lack of visual prompts was echoed by the members of staff checking context records with many of them feeling that it makes the records more difficult to check because you can't easily see what is missing.

"Because when you look at the card, when you're used to them, you obviously know which boxes should be filled in for what. Whereas, because it's just a list of codes in the digi pen books, it's quite difficult to sort through and work out which bits…"

(P2, 2008 User Discussions)

"I suppose when you're checking a paper context sheet you can immediately see exactly what's there and what needs to be filled in and you can immediately see if something's missing."

(P12, 2008 User Discussions)

"But at a glance with a digital context page, you can't see what hasn't been filled in, and there isn't a template that's there easily for the supervisor to check through, and you can't expect a supervisor to have this encyclopaedia knowledge of everything that goes on a context sheet."

(P13, 2008 User Discussions)

"It is easy to check that the information written in the books is correct, but not easy to make sure that all the relevant information has been written up (on paper context sheets it is easy to check for empty boxes)."

(P14, 2008 End of Season Review)

Many members of staff admitted that they found the digital notebooks so difficult to check that they waited until the information was printed out in the traditional CRS format. This was common to all staff, even those who were positive about a digital recording system. It seems likely that leaving checking until this stage means that there are more corrections that need to be made after the information has been added to the IADB. Field observations and discussions revealed again and again that many users would be happier if the digital notebooks looked like the traditional CRS.

"It would be really nice, I know it's expensive, but to have it looking almost the same as a context sheet does now. I know that is a lot more money but I think that would become a lot more user friendly. Just a list, as it is at the moment, isn't as user friendly as it could be."

(P15, 2008 User Discussions)

"However, from the point of view of being used to standard context cards I think it was a lot harder to get used to, because I'm used to doing one way and it's learning a new way."

(P18, 2008 User Discussions)

"And the one big issue I have with them is the books not having the context sheet printed on the page."

(P19, 2008 User Discussions)

"I guess if each of the, if the book was laid out like a book of context sheets that might be easier."

(P20, 2008 User Discussions)

"Would it be possible – instead of having blank pages in the book, to have like the context cards printed out on them?"

(P24, 2008 User Discussions)

As well as not looking like the traditional CRS the digital notebooks are perhaps less user friendly because each context is not a physically separate card. The existing work flow for the traditional CRS is easy to follow because each card can be treated separately and filed in the appropriate place at each stage. The digital notebooks keep all the contexts together and even if they are written on separate pages they are not able to be physically separated into different files etc. This means that it is difficult for an individual or a small team to keep hold of all the relevant contexts records for an ongoing project[18].

"The other thing that's come out of our sort of pilot is that where we've dug those slots through a complex of like lots of intercutting ditches, the people who've dug those slots have had to do 30 context sheets in order to completely record their slots, and they've not been able to do that in the digital books because they need to be able to cross-reference all their numbers and to go back

18 This could be overcome if there were enough pens and notebooks.

"I think more books – we'd like more books, like per area, because I mean, three's just enough, but sometimes, people were waiting, yeah, more books." (P9, 2008 User Discussions)

and check all their sketches, and to go back and – it just wasn't feasible with the digital book."

(P13, 2008 User Discussions)

One positive comment that users made about the layout of the digital notebooks was the fact that it is not necessary to find the original record to make additions or amendments. This was thought to be particularly useful for cases where a number of contexts need a sample number or the like added to them. Not having to find the original record saved users time and effort. There is a possible downside to this as not finding and checking the original record before making additions assumes that the user's knowledge/memory of the record is correct. There is also potential for context records to become split across digital and paper records which could lead to problems for checking and archiving.

"if you've suddenly got additional information about an old context, then that's a very quick way to add it to the database without having to mess about with the sheets."

(P13, 2008 User Discussions)

"I found them quite easy – easier than writing out a context card normally, cos you can just go back and re-do it whenever you want, so after you've removed it you can add like small finds if we find any or anything like that, and it's easier than going through, looking for a context card and then having to write it in the, yeah."

(P22, 2008 User Discussions)

One user noted that unless some sort of index is kept or corrections are made on the same page it is likely to be difficult to track down all corrections and updates.

"I don't know how realistic it is to expect that they'll be, well I don't think it's going to be very easy to find a string of corrections and updates throughout a notebook, unless you are also keeping a very careful index somewhere."

(P12, 2008 User Discussions)

Some groups tried to make things easier to find by attempting to keep one context per page, but this was not always successful.

"I think, yeah, sort of things like trying to make sure it's in the same book, trying to make sure they sort of keep it all together on the same page, that they sort of do it in a reasonably sensible fashion,"

(P9, 2008 User Discussions)

"In terms of checking them, although we've tried to keep it so that one context is per page, there's been numerous circumstances where they've had to go back and change things or somebody's written it on a page too early and they've had to add things."

(P2, 2008 User Discussions)

9 A Hybrid System

During the 2008 season amendments were made both in the digital notebooks and also to the printed CRS and that this was a source of some confusion. Some of the confusion stemmed from users not fully understanding how the digital pens worked and some of it was the result of there not being a clear system to follow. Some users appear to have been confused as to how they should make corrections in the notebook if they did not notice a mistake immediately as they were writing. It was observed that amendments were being made both in the digital notebooks and to the printed CRS and that when they were made to the printed cards users frequently became unsure which was the latest version.

As mentioned above, some supervisors waited until they had the print out of the digital notebooks before they checked them. It seems likely that leaving checking until this stage means that there are more corrections that need to be made after the information has been added to the IADB. There needs to be a clearer system for making amendments, especially for records that have been already digitised. This would appear to be an area that requires further documentation and/or additional teaching as a more streamlined system would reduce confusion and save time.

"– I think amending the sheets has been the source of some confusion for some people this year, like obviously we've been amending either the printouts or in the book, and that's sometimes where there gets confusion, if it's been amended more than once particularly, we've sent it back again, and then the amendments have come back but the amendments haven't been made because XXXXX has gone, "oh, this has already been amended", but it needs to be amended again."

(P9, 2008 User Discussions)

"Technically -so how do you know whether you're just adding additional information of if you're adding new information to over-write the old data – so that's been a specific issue of checking."

(P13, 2008 User Discussions)

"I think there's an issue there with updating them and keeping them up to date once they've been digitised. I think trying to smooth out that system would be beneficial."

(P15, 2008 User Discussions)

"There seems to be a lot of going backwards and forwards with them. If we could narrow that down it would be a lot better. The thing is you do your context card and it goes and gets digitised and then printed out. And then you realise stuff is wrong. Rather than just being able to just correct it on the context card…"

(P15, 2008 User Discussions)

The 2008 digital recording system at Silchester was a hybrid system that involved both digital data and paper records. English Heritage's Revelation project highlighted the inefficiency of such hybrid systems and at Silchester the mixture of digital and paper has been the source of some confusion on site. Amending paper printouts of digitally recorded contexts requires manual inputting of changes and can lead to problems with version control.

"I think it's a problem because we're still trying to use two separate systems, the way we're doing it now."

(P13, 2008 User Discussions)

"And again that seems to me a little bit… rather than writing the context card, it going to be digitised, and coming back and we just have the digitised record it seems we're using one set of expensive paper, going back and then printing it out again and that seems a little it anti-environment to me."

(P15, 2008 User Discussions)

10 Ownership & Investment

Developing a system for managing the digital pens needs to involve the people who are supervising their use on site and this is an area that would benefit from further exploration prior to using the digital pens on site in future seasons. One participant described the digital pen work flow as "awkward" and it seems that this is the heart of the problem. The system for the paper CRS has been developed over years in

consultation with field staff and as a result is straightforward and easy to use. If a digital context recording system is to achieve the same then the process needs to incorporate all the strengths of the paper system. There did seem to be a will amongst most of the supervisors to work through the process, as long as they are involved in future developments.

"It was different and a little more complicated however I feel in time these kinks will be worked out."

(P9, 2008 End of Season Review)

"Just as useful but a little awkward compared to traditional methods."

(P7, 2008 End of Season Review)

"I think the key things is that we need to develop a system maybe amongst the supervisors to amend and check them in the books."

(P9, 2008 User Discussions)

One member of staff suggested that some of the confusion over amendments might be solved if supervisors and assistant supervisors managed the upload of data themselves. This would mean that they could chose when to upload the data and that they would be able to check it at that point before printing anything out. There is obviously an issue here about the additional work that this would create for staff and the additional computer hardware that would be required to make it practical. It would, however, give staff a greater level of control over the site data and allow them to be better informed about their area.

"No, I think we'd be fine with it…in a way that might actually solve some of the issues because we'd be able to keep track of amendments and checking it, and we'd be able to check it digitally, and I mean one thing me and XXXXX came up with was using the Palm pilots you know or, maybe just having a couple of laptops that the supervisors could use, to check…"

(P9, 2008 User Discussions)

"to do things digitally, and to check them, see what's going on, what we've actually got in the database, what needs to be put in the database, just so we're sort of a bit more in touch with at what stage that context card is at in the database"

(P9, 2008 User Discussions)

"There are some issues about uploading which need to be addressed - supervisors should upload and check as they do so."

(P10, 2008 End of Season Review)

At the beginning of the season there was a sense of slight unease when the proposed system for using the digital pens appeared to take responsibility away from supervisors and assistant supervisors. The issue of staff involvement in shaping the new recording system seems key to its success. If staff are disenfranchised and alienated they are unlikely to support changes to their work patterns. One supervisor went so far as to say that they felt they had no control over the records for their area.

"I've got basically no control over what's happening with the sheets."

(P13, 2008 User Discussions)

Although other supervisors and assistant supervisors occasionally complained that they were having difficulty getting access to their context sheets this did not often become a major problem. The majority of supervisors and assistant supervisors felt that they were involved with the development of the digital recording system and observations and discussions showed

that they were successfully integrating the digital pens into their daily routines.

"I think again this season – whereas previous seasons there was a kind of negativity to the digital recording, I think again this season the whole attitude is a bit more positive, probably because as I say the supervisors have managed to integrate it into their daily routine much better, whereas before it was a bit of a burden."

(P22, 2008 User Discussions)

An important question to consider is whether the digital recording system does actually save the project time. Many participants seemed to believe that the digital pens did away with the need for post-excavation processing of context data. Whilst the digital pens do reduce the amount of information that has to be manually input into the IADB the download process does require checking, interpretation and correction.

"So I was actually wondering how long is it taking to actually digitise these things and do the bit of interpretation that's required and, you know, sort the corrections out when the pens are uploaded? And whether it's actually any faster to upload the pens with the interpretation than it is to actually input a context sheet."

(P12, 2008 User Discussions)

11 Conclusion

The 2008 field season at Silchester provided the opportunity to study the use of the digital pens in more detail than in 2007. The majority of staff at Silchester are supportive of trialling digital recording methods and are keen to be involved with the process of shaping new recording systems. Their involvement seems key to the development of an efficient and effective digital recording system.

"I think there's a lot that could be improved, there's a lot we could work with, but I definitely think it's a good idea and a step in the right direction."

(P6, 2008 User Discussions)

"I don't think there are really any problems that we've encountered this year that can't be overcome you know, it's not like you know 'oh my god, we just can't work with this'."

(P9, 2008 User Discussions)

In this paper we have demonstrated issues related to the integration of new technologies into established archaeological processes. Concerns regarding the robustness of the digital pens in the archaeological environment were quickly overcome, but issues with establishing the digital pens (and their related context sheets) as part of the recording process at Silchester centered around the fact the new technologies did not mirror the existing system. There needs to be more teaching for staff so that they are more confident about supervising the pens and perhaps compulsory teaching for students. The system of recording contexts with the digital pens needs to be more thoroughly thought through so that it is as clear as the system for paper CRS. The layout of the digital notebooks was repeatedly cited as a problem for both users and supervisors and it would be beneficial to look at this issue again. Ultimately the goals of digital context recording must be to make records more quickly and easily available to site staff and specialists and to reduce the time taken to digitise context records; whether the digital pens do this at the moment remains unclear.

This research has demonstrated the importance of factoring in user needs when integrating digital technologies into existing archaeological practice. Unless the voices of those working with the

system are acknowledged, any new implementation of technology will not fit into existing working patterns, and so stand little chance of being adopted. Additionally, unless digital technologies replicate the existing methods they are designed to replace (or enhance), such as digital forms mirroring the established context forms at Silchester, they are doomed to failure. Using IT in the trench is not as prone to failure as might be expected given the extreme nature of weather conditions often encountered: but may be prone to failure through not taking into account the needs, practices, and habits of those for whom it is designed to help

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