Timing in the Art of Integration: 'That's How The Bastille Got Stormed'

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1.ABSTRACT

This paper uses a long term ethnographic study of the design and implementation of an electronic patient records (EPR) system in a UK hospital Trust to consider issues arising in the multi-faceted process of integration when a customizable-off-the-shelf (COTS) system is configured and deployed in a complex setting. The process involves trying to artfully work out how disparate technologies integrate with existing and evolving patterns of work within developing regulatory requirements. We conclude by suggesting ways in which ethnographic interventions and user involvement may be timed and targeted to aid in achieving this process.

1.1Categories And Subject Descriptors

H.5.3 [**Information interfaces and presentation**]: Group and organization interfaces - *Computer-supported cooperative work, organization design*; J.4 [**Computer applications**]: Social and behavioural sciences - *Sociology*; D.2 [**Software**] Software engineering; H.1.2 [**Models and principles**]: User/machine systems - *Human factors*

1.2General Terms

Design, management, human factors, standardization

1.3Keywords

Integration, electronic patient records, healthcare, COTS systems, ethnography, ethnomethodology, configuration

2.INTRODUCTION: INTEGRATION & UK HEALTHCARE

The UK National Health Service (NHS) is currently undergoing a period of 'modernization' through computerization (Bloomfield et al. [2] argue this period has been going on in different guises since the 1980s). A major component of this modernization is to provide comprehensive, integrated computer support for all hospital 'Trusts' (comprising 1-3 hospitals in an area) through the deployment of electronic patient record systems (EPRs) in the next 5-10 years. The goal is to produce systems that support and facilitate *clinical work* as well as *administrative* and *reporting functions*. The systems are expected to enhance medical work through the provision of information which is robust, accessible at the point of service and timely, while also facilitating best practice, decision support and so forth.

Equally, new systems are expected to support better integrated group and organizational working. Currently, in many UK hospitals, computer systems have been acquired on a piecemeal basis and are used for particular functions, specialities, departments etc. and are rarely integrated. Instead, the integration of processes is currently managed locally, largely through 'handover' practices associated with paper documentation that have been informally developed [6,10]. Secondly, health services are meant to be integrated and computerized on a regional and national basis. Trusts are on a trajectory that requires them to integrate their services electronically with those of other care providers in their area, most notably general practitioners (primary care) but also mental health care and potentially social care. At the same time they are required to provide core sets of data expressed in standardized formats for national purposes. Integration, then, is a problem at three levels: internally; cross-organizationally (regionally), and nationally and must be worked out in relation to constantly emerging and changing requirements.

The situation in the domain of UK healthcare with regard to levels of computerization, standardization and integration is often seen in sharp contrast to US healthcare and business sectors such as financial services where much of this process has been accomplished more or less successfully. However, our research into the UK healthcare system offers us an opportunity to examine issues of integration of multiple disparate systems and of systems and work processes in the course of a large-scale and complex implementation process. Indeed the task here is particularly complex as this process is occurring when:

[1] The systems are envisaged to support multiple and varied medical, administrative, reporting and regulatory processes, rather than just providing administrative support. Essentially, the heterogeneity of healthcare information and practice pose particular problems for integration [6,8].

[2] The technologies incorporated in EPRs are more complex and sophisticated – e.g. utilizing imaging and visualization technologies, decision support and Internet-based applications, and are supported by innovative technologies such as wireless and mobile devices.

[3] Requirements as dictated by the NHS are emerging, developing and changing as successive programs are put into place and defined, meaning that system development needs to be flexible and responsive to future requirements.

The UK Government has instituted a program to deliver the systems required to achieve this process. Trusts will work with a private supplier in a public private partnership (PPP) where the supplier is contracted to supply, implement and maintain the systems for 8-10 years. Customizable-Off-The-Shelf (COTS) systems offer one means to do this. The deployment of COTS systems is an increasingly pervasive arrangement as fewer organizations seek to develop systems in-house. COTS systems offer the possibility, to some extent, of a ready made design solution without having to build from scratch. In principle, the degree of flexibility they afford allows for some integration with existing (and evolving) work practices. On the other hand, there are costs for the supplier organization associated with developing and maintaining fully configurable systems. It is in the interests of the COTS supplier to provide just enough configurability to meet the needs of their customers, so as to benefit from having only to maintain and support use of a single, manageable, code base. In consequence, COTS systems are typically not radically configurable, but rather exhibit a 'designed for' configurability that anticipates the ways in which the settings in which they might be deployed can vary. This creates a key set of design problems concerning how to fit the system to current social systems of work (or *vice versa*), to existing legacy systems where these are set to remain, and to new technologies also being introduced. This will inevitably involve tailoring or configuring the COTS system while also transforming patterns of work. Getting the balance right in this process is of crucial importance.

In this paper, we focus on the results of a long term ethnographic study of the design process in a hospital Trust ('The Trust') in the North of England that has just 'gone live' with phase one of an EPR deployment. We do so as a means to investigate the multiple issues of and problems for integration in UK healthcare as they pertain to this trade-off between cost and flexibility. Although our work here is more of an ethnography *of* design rather than ethnography for design, our reflections are aimed at better understanding how ethnographic work can provide 'points of intervention' for design teams. While some of our findings are specific to this Trust and the UK NHS, issues related to implementing COTS systems and the multi-faced nature of integration are pertinent to a wide range of systems design projects.

3.FORMS OF INTEGRATION & KEY DESIGN QUESTIONS

Vic – *"X has drawn my attention to upcoming changes in procedures – it is important that these are done before go-live so they are not associated with the system. If they are done before go –live, the system will be seen to automate and speed this up. If not then you'll have a revolt and that's how the Bastille got stormed."*

This quote comes from a project meeting during the development of the EPR at The Trust. Vic, the chief analyst for the supplier, 'OurComp' articulates an integration issue – about how the new system will integrate with existing work practices. His concern is that if the EPR system is used as a means of introducing new procedures it will inevitably require learning and adaptation and may lead to negative perceptions about the system such as the notion that it has increased the work that users are required to do. But, if the procedures can be implemented prior to deployment, problems will be associated with the procedures themselves and the EPR system, instead, may even be seen to improve matters. Timing, for Vic, is crucial in how users understand the impacts of organizational change and attribute blame for problems.

From a technical perspective the common issues of integration are about how to integrate specific technologies so they can communicate and exchange data effectively. This is clearly an important issue. However, we would like to draw attention to the fact that integration is a multi-faceted issue in large scale systems design projects such as the one described here. The Trust studied had not previously operated with a set of formally described integrated (and computer supported) set of procedures. Essentially, as patients progressed on their trajectories of care their paper records and any related handover work served as the means of integrating the work of different departments. Patient data was stored on a variety of different computer systems in different departments to support work associated with specific disciplines or administrative functions. Therefore, 'integration' for the 'Trust' was also about formally integrating processes, via the EPR system, that were previously integrated informally. A corollary to this is that integration in this form also involves some rationalization and standardization. That is, 'similar' processes carried out across different departments in the hospitals such as the running of clinics, ordering services and supplies, booking appointments, carrying out surgery etc. should be realized as having a generic form or as certain 'acceptable' variants of a generic form.

As shown in the quotation above, integration is also about integrating new technical systems with pre-existing work practices. As demonstrated in studies of socio-technical system research and development there is a danger of failure if systems do not mesh well with existing work practice and do not support important social aspects of work [1,7,11]. While this has been seen by some as evidencing a 'conservatism' in ethnography, we would argue here that the critical issue is the change process. Whatever the current state might be, and whatever future state is envisaged, the change between the two needs to be effectively managed and we cannot simply assume that radical transformation without respect for existing practices will deliver the anticipated future state. The integration problems we describe exemplify this change management process very well. As Sommerville et al. [14] point out, careful design involves successfully sorting out how the following four non-trivial 'problems' relate to sets of requirements[1]:

[1] What characteristics of the existing manual system are unimportant and need not be supported in an automated system?

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[1] A fifth problem might be added to Sommervilles' list, namely: 'What activities not present in the manual system become necessary following the introduction of the automated system? How can these be integrated with residual manual activities and how might they need to be supported through training?'

[2] What are important manual activities which need not be supported in an automated system because the activities are a consequence of the fact that no automated support is available?

[3] What characteristics of the manual system must be replicated without change in an automated system?

[4] What activities from the manual system may be supported in a way which is different from that used in the manual system?

There is one other way in which integration had to be addressed in the EPR deployment, and that is of integrating the work of the Trust as realised in the new EPR system with wider organisational and regulatory requirements. The system provides the Trust with an opportunity to manage organisational change, and to collect new sets of data, and during the course of the project the UK NHS, produced a set of requirements that the EPR system had to meet. Hence we have 4 types of integration taking place:

- **Technical integration of disparate systems:** the integration of the core patient records system with modular systems for certain specialities such as accident and emergency, theatres, radiology, and with the legacy applications used in pathology and with new imaging applications. Issues such as data quality and matching come into play.

- **The integration of workplace procedures:** in this case by implementing generic process models in the system. This immediately introduces a tension between standardization and supporting local variants in practice.

- **Integrating the system with work practices:** a good fit is achieved by successfully sorting out how the four questions posed by Sommerville *et al* relate to specific aspects of theses work practices and this design.

- **Integrating the system with wider organisational and NHS concerns and requirements:** these emergent requirements were given priority – they had to be met - meaning that attempts to meet other requirements such as those related to 'human factors' can only be made subsequent to these key requirements being met.

These different integration activities did not take place concurrently and independently, but rather our fieldwork revealed complex interdependencies arising from their conduct. While these might sometimes be anticipated and attempts made to manage them (as the example at the beginning of this section suggests), it was just as likely that the consequences of one sort of integration upon another emerged as problems for the design team as the design of the EPR progressed.

4. SETTING & STUDY

In 2002, The Trust signed an £8.3 million, 9 year contract with US based software provider OurComp to supply, implement and support an EPR system. The system was due to be delivered in 3 phases between 2004 and 2006. Phase 1 (a core administrative and reporting system, theatres, A & E, radiology and links to legacy laboratory applications) went live February 2005 after being delayed a number of times since the previous February. The second and third phases will bring other specialities and GPs on-line, incorporate automated pharmacy applications, care pathways and so on, realizing the system as a fully-featured EPR.

Our fieldwork began in May 2003, giving us access to study the design team as they progressed the design. The research is important from a UK NHS perspective as it focuses on an 'early adopter' in the UK program involving a configuration of players and stakeholders dealing with design and integration issues that will be repeated in similar circumstances across the UK. From an international perspective the research is important as it focuses on the particular socio-technical issues and tensions involved in configuring and deploying a COTS system.

OurComp provided a COTS EPR system to be configured for the Trust. This was to be integrated with other legacy applications (particularly those used for laboratory work). The business of building and configuring the system was managed in partnership – i.e. a joint project team involving members of the Trust and OurComp. This meant that the Trust and its employees were *customers*, *users* and *joint designers*. OurComp's analysts and designers essentially act as intermediaries between the Trust and their employers dealing with the tensions between the Trust's desired requirements and the degree to which OurComp was willing to (or could) tailor the system for them. With the proliferation of COTS system development projects in many sectors, involving similar design arrangements and contractual relationships it is important that we gain a better understanding of the design process and the types of issues it reveals.

The material in this paper is taken from observations of the work of the UK project team in conjunction with OurComp's analysts. In the last 2 years we have attended meetings of many sorts involving the project team, 'shadowed' team members, attended testing and so forth and have collected a wealth of material (field notes, tape recordings and various documents). There are many players involved in the project. In OurComp 6-8 analysts are seconded to work 'full-time' on the project as well as a manager located in the UK. They are the day-to-day 'face' of OurComp for the Trust. However, other staff are working 'behind the scenes' in the US helping develop the application, and at particular times (e.g. during testing and training) other OurComp staff travel to the UK to aid in particular stages of the work. The project has been split into a set of 8 modules (patient administration, theatres, accident and emergency (A & E), radiology, interface conversions, reporting, order communications and medical records) with a designated team for each. Each team comprises a Trust analyst, an OurComp analyst, a team leader (a manager from that area) and various 'users'. The implementation team – the analysts who are quoted and referred to for much of this paper – is a specialist group comprised of the Trust and OurComp analysts from each of the 8 modules. It is the implementation team that carries out most of the day-to-day systems work – in terms of specifying what the build of the database should be and then carrying it out, demonstrating it to 'users', then refining, and re-building.

5. ANALYTIC THEMES & ORIENTATON

In this study we adopted the approach of ethnomethodologically-informed ethnography [11,12] for the data collection and analysis. This type of approach has most commonly been reported in the Computer Supported Cooperative Work (CSCW) and Human-Computer Interaction (HCI) communities. These studies usually take the form of detailed descriptions or explications of 'real-time

real world' work or other activities. Ethnomethodologically-informed ethnographies focus on detailing the ways in which work or activities are organized by their participants as recognizable social accomplishments. Of typical interest are the ways in which participants: (1) carry out their work in relation to plans, procedures and rules, (2) coordinate their work, whether face-to-face through talk or in some manner mediated by artifacts and technology, (3) share awareness of one another's activities, (4) order and organize their activities in relation to the ecology of the settings they work in, and (5) how they practically reason about the activities they are involved in. Usually these studies are employed as a means of understanding application domains either to derive requirements for systems to more closely afford work, or to examine how well work is supported by existing systems.

In this research, however, we take a different tack. Instead of explicitly studying medical work in the Trust as a means to inform the design of the EPR system, we studied the work of design and project management itself. In this way our work is most closely related to that of Button and Sharrock [3,4] and potentially Grudin and others [5,9,13]. In doing this our first desire was to understand how design progressed 'in the wild' – how design was organized and coordinated, and for this paper, particularly, how analysts reason about the application domain, users, problems and the emerging design. We concentrate on how the analysts grapple with the business of integrating the COTS system with systems of work, while also dealing with the need to integrate processes, integrate technologies and integrate the system with NHS requirements. Our research background also leads us to consider three other questions: *Firstly*, can we identify important design activities that might be better supported? *Secondly*, can we understand how the analysts researched and reasoned about the social systems of work they were designing for? *Thirdly*, given the usefulness of ethnography for revealing practice in application domains, is there a role for ethnography to inform the work of the analysts? The latter question is an important one, because employing ethnography as part of the design process in complex, large scale settings like hospitals is problematic. Historically ethnographies tend to focus on a small and self-contained settings or activities, with scaling up presenting difficulties associated with simultaneously being present in multiple fieldwork locations, examining a large number of activities, and subsequently making sense of the voluminous data collected [12]. Put simply, to do an ethnomethodologically-informed ethnography of a hospital as a whole is an undertaking beyond the resources of most projects. Despite this are there other ways the benefits of ethnography to systems design can be applied in such cases?

6.ACHIEVING ARTFUL INTEGRATION?
Achieving successful integration here is about successfully managing the four types of integration while acknowledging that requirements for one form of integration may have preference over another. NHS regulatory requirements *must* be met, the new EPR system *must* integrate electronically with legacy applications and previously informally integrated processes *must* be integrated on the new system. When compromises need to be made, flexibility is generally found in the degree to which 'local' tailoring of interfaces and functionality for particular groups of users may be de-prioritized. This happens when other integration requirements, which are considered more important, conflict with local

requirements, or problems related to them simply take up more time in a tough development schedule. In these cases there is a desire to turn any problem with local requirements into a training issue. Deciding whether it is unproblematic to do so clearly raises for the analysts the set of questions described by Sommerville *et al*. (see above). These concern working out which current processes and practices need to be preserved, should be computer supported, may be transformed, by which means, and so forth.

6.1Defining the Current Structure of Work
There is always an unknown 'factor' when analysts consider current work processes and practices with Sommerville *et al*s' questions (or similar versions) in mind; it is to some extent impossible to know in advance all of the impacts a new system will have on work practices. These will inevitably evolve in response to the new system, even in cases where the design is intended to mesh closely with existing patterns of work. Most often, however, the desired design is envisaged to 'preserve' certain adaptive, or desirable, patterns of work, while transforming inefficient, maladaptive or inconsequential practices for organizational gains. Either way, better decision making in this process should be facilitated by a detailed understanding of current process and practice. However, when we examine the design process in the Trust we can see that a key problem is in gaining a full understanding of what current process and practice is. For example in the excerpt shown below (taken from an analysts meeting early in the build process) Barney (a Trust analyst) relates his difficulty in getting the information he requires to build the clinic scheduling application for the new system. His design problem is that his information on current process and practice, on which to base the new design, is 'incomplete' and in the wrong 'format' and heterogeneous and he is unable to access users who can provide him with the information he requires:

Barney – **"***For this area we need many different users to test as it is different for different areas. I'm basing the build on call centre information. There's a problem that the build comes from either PAS or how you do it. Information has not been provided in full or in a format to be used so I think I will just have to go on how PAS does it."*

Alice – *"I think this has to go to the IM & T steering group"*

Barney – *"We wanted to set up clinics the way they work – it would have been magnificent, but have to go to PAS instead. No-one in this hospital is capable of providing a list of clinics."*

Barney draws a distinction between understanding *'clinics the way they work'* and *'PAS'*. [PAS is the legacy patient administration system]. He is airing a concern that designing based solely on the data items and processes on PAS misses out on the possibility of configuring the new system to fit better with actual working practices. Barney formulates this as a missed opportunity for design as *transformation*, but of transforming the system to fit better with work, rather than transforming the work itself. Barney's statement can be contrasted with the next comment in the excerpt by Alice, one of OurComp's analysts:

Alice – *"Enterprise wide scheduling would be full integration of a series of procedures, bringing resources together in the 'correct' order to support care…. the system would automatically work out what can be done, when…*[and] *indicate what is required, as opposed to scheduling that is not seamless across procedures."*

Alice follows Barney's comments by stating a design ideal of 'enterprise wide scheduling'. While Barney conceived his problem

as the missed opportunity to configure the system to better fit with work practices, for Alice it presents a problem for achieving a full integration of procedures. Her 'vision' is of creating a standardized, efficient and effective transformation of work through the introduction of a new system. Both visions may not be incompatible, however, it is important to recognize that different visions or of the purpose of design co-exist. As the excerpt develops we can see that the lack of complete information has become a serious problem because they are running out of time.

Alice – *"We need to make a cut-off date."*

Barney – *"I could do it, all I need is a correct, full data set.....Other jobs got in the way of chasing up the data."*

Alice – *"There's a real problem of the validation of the data set".*

Helen – *"There's a problem of change management going on in the Trust right now, particularly in the call centre, there are disputes over how things are currently done and the requirements for modernization."*

Barney – *"Well I'm not going to worry about other people giving me the right information as long as its signed off."*

Alice – *"But I must stress the importance of buy-in from the most tricky people and areas during QA* [Quality Assurance] *testing."*

Alice draws attention to the problem of the 'validation' of the data set (the requirement for users to sign off the data set) before Helen (the Trust project manager) offers her insight into the problem. Helen suggests that the problems Barney has experienced with regard to the hospital call centre relate to disputes amongst stakeholders about current work and how to transform it. Her statement resonates with Vic's 'Bastille' comments reported earlier, in that it highlights the difficulty of designing and deploying a COTS system against a backdrop of disputes about organizational working and directions for transformation.

Barney then suggests that he has reached a stage where he is focusing on sign-off, rather than on the information being 'right'. However, Alice then draws attention to the need to keep 'tricky' users on board during this process, as if they don't, problems may occur during the later stage of QA testing. If there is disagreement amongst users about the data set, such that it has been difficult to collect, then there may well be problems in getting it signed off. If it is not signed off then there may be problems progressing to the subsequent stages of design. Therefore, we can see a number of issues regarding design and integration being discussed here. Achieving a successful integration and transformation of processes, supported by the new system is problematic when analysts are unable to gain an accurate picture of current operation. This is not just a matter of access to people and materials, as the project has revealed that these matters are also contested. This creates serious issues, when project timeframes dictate that a description of current data sets and processes must be validated soon. And members of the project team are well aware that this validation may be disputed at later stages of design, particularly testing, where the users have strong involvement.

6.2 Integrating the System to Work Structure

Many discussions that occur during project meetings and other project work, relatively early in the design process, during *development* and *configuration,* concern deciding how well the emerging system fits with the current structure of work. The current structure of work has three basic inter-related aspects:

- **Temporal Structure:** work follows certain routines and rhythms and unfolds in particular ways in particular settings.

- **Spatial Structure:** work is structured in relation to the ecology of a setting and the specifics of the setting and the placement and movement of people and artifacts afford information about the status of work.

- **Social Structure:** work is organized as participants coordinate their activities through talk and action with, through and around paper and computer-based technologies.

In many cases the analysts conceive that there is no 'bad fit' between the structure of the system and the structure of the work it is meant to mesh with. We, however, focus on the problem cases, where there is a perceived bad fit between the system and one or more aspects of the current structure of work. For example, in the excerpt below (from a Trust analysts' meeting) a discussion begins with the A & E analyst (Bob) discussing with Lenny (the pathology analyst) a problem that 'A & E staff may not remember to log out of the system' if they are called away suddenly to an incident. Bob suggests that since currently staff do not have to log out of their system, they will not do so if required by the new system. Lenny responds by suggesting that the new system could automatically log users out once they had stopped interacting with it. Bob then raises the problem that another user might then use the system under the previous person's signature which would be a concern for both security and the integrity of records.

Bob – *"Because if they've got to log out people will not log out of it they don't now .."*

Lenny – *"But maybe they won't have a chance because the log in time out will..."*

Bob – *"Well I understand that .. but if it doesn't time out before someone gets their hands on the keyboard, .hh that next action is taking place under someone else's signature"*

Lenny – *"Mm hm"*

Bob – *"And that's a problem"*

Helen – *"Mm hm it is a problem"*

Bob – *"And in A & E, in that chaotic, you know, environment, they will not log out"*

Bob suggests that because the structure of work is 'chaotic' in A & E users cannot necessarily finish every system 'task' they begin. The 'task' may be left open, with the user still logged on. The analysts then consider whether this problem can be solved technically. They discuss whether an optimum time-out can be set, considering *temporal* aspects of the work. However this idea is dismissed as the shorter the time-out (which would suit for security), the more problems for usability (users would inadvertently be logged out when they stopped typing). They also discuss the possibility of using a plug in key device or biometrics for access and authentication but these are rejected for other reasons. We return to the conversation as the project manager (Helen) proposes her 'solution'.

Helen – *"Well and again ... this is one of the reasons why we've asked for the IT trainers here as well so that this is ... yesterday I met with the IT trainers and we started talking about some of the issues that we need to make sure that everyone is aware of .. this is one of the key ones, making sure that people log out and understanding the implications because in a fact it's an electronic signature, and that's going to give a print, of where*

you've been on the system and if you don't log out you're allowing someone else to use that signature"

Bob – *"But it's not a training issue.. the fact is that the log out procedure will not be looked upon as important as treating a patient"*

Helen – *"Sure"*

Bob – *"And in that environment they're not going to turn round, and log out, every time they walk away from a PC, I can guarantee that"*

Helen – *"Yeah so we need to look at it, I agree it's not completely a training issue I do think it is partially a training issue"*

For analysts there is an on-going consideration of what the design is and how this corresponds to their understanding of the current structure of work. Through their discussions with users and observations of work they make decisions about the fit of the system to work practice and raise them as problems when the 'fit' is considered bad. The system logging on and off procedure is described as a bad fit with the actualities of A & E work – where other duties will sometimes take priority over logging out. The team search for a technical solution and, interestingly, when no workable technical solution is found Helen re-casts the problem as another type of problem - as a problem of current practice - and therefore something to be dealt with by a change in practice. The solution is to be implemented by training that stresses to the users that their personal integrity with the system is compromised if they do not log off. This new conception of the problem, however, is modified by Bob when he re-iterates that other matters naturally take priority in A & E suggesting that it would not be a question of staff deliberately going against what they were trained.

Here, what is particularly interesting is the *mobility* of problems and solutions. Problems of usability can be problems to do with the system or to do with the users. In this case the problem is set as the 'system not fitting in with the users/users environment'. However, when no easy technical solution can be found it is re-cast as potentially being a user problem – 'resistance to change'. But in this case the solution of 'training' is rejected and we reach (for now) an impasse on how it will be solved. In general, technical solutions are preferred as they 'solve' the problem, while there is always doubt about how well training will stick and how well users will adapt. However, it is worth noting that when a technical solution is not found (even if the team agrees it is a thoroughly technical problem) it inevitably becomes a problem to deal with through user adaptation (hence why workarounds proliferate during the course of a project).

In the previous log-out problem example there was no discussion about whether the problem was the *responsibility* of the Trust or OurComp's analysts. In the following example we can see that these issues do enter into analysts' talk about problems of 'fit'. The extract begins with Lenny discussing how the data entry process for laboratory access to the new system is not 'slicker' and 'smoother'. The problem is that lab staff are being asked to input five items of demographic data, when previously they only had to input a single code. In consequence the new system will be less efficient, produce bottlenecks and therefore users will view the system negatively – it will change the current *structure* of work for the worse.

Lenny – *"If the data entry process does not work in a smoother, slicker fashion there will be bottlenecks which will slow the process and cause problems... we already attract criticisms and problems with GP ordering which will be manually input... It sounds like 5 steps when currently it is only one step – we only take one code".*

In the next part of the conversation Vic explains that the reason for requiring the 5 demographic details is that the application (a GP (doctor) finder) is generic to the system and requires five items for the Commissioning Data Set (NHS requirements). The reason for the 'problem' is due to requirements for producing an *integrated* system, *integrated* with Government requirements (Interestingly, 'for the purpose of integration' and 'for NHS requirements' become progressively the most prevalent ways designers account to users the reasons why they must do more work, or the usability is not what desired). This view is partially rejected by Alan (pathology team leader) who takes up the issue of integration but lodges it firmly as being a *supplier* rather than a *user* problem - it is the supplier's problem to achieve integration while achieving the same level of service for users.

Vic – *"You need to have the ability for other areas of the system, what should be easy is a problem because you risk the CDS integrity".*

Alan – *"Integration is the number one job...it's how systems will become part of the family... it's an issue for OurComp, fitting legacy lab applications to the EPR".*

Helen – *"Can someone take a stop-watch and time this?"*

Alan – *"It will take twice the time, more personnel and over 100,000 transactions you can imagine... it takes Lenny longer and he knows what he's doing".*

Helen – *"We need the timing so we can take it up as an issue".*

Alan – *"It's the same thing for Bob and A & E, it has great importance for system success, if inputters aren't happy, the department's not happy".*

Here the problem is framed and measured in different ways. Firstly, by Lenny as an efficiency problem that would lead to an interrupted process viewed negatively by the individual users, due to the new system integrating poorly with current work practices. Vic responds by suggesting that it is inevitable due to the need to integrate processes and to meet NHS requirements, essentially suggesting that these are more important forms of integration to attend to, and that the usability problem is not the priority problem for the supplier. This is turned around by Alan when he suggests that problems of integration *are* problems for the supplier. Here we can see how the different forms of integration get argued about, prioritized, and even potentially confused in the design.

Helen then asks for the problem to be timed– so she can make a case to her superiors. Here we also see some of the 'escalation' techniques used to get a problem identified, categorized and accepted as serious. For example, by indicating that a bad fit with current work will be bad for efficiency, or by scaling the problem up by looking at the wider organizational picture (100,000 transactions) or suggesting that the problem is more widespread (it also affects other areas) than originally thought.

7. INTEGRATION & USER TESTING

So far our examples have dealt with discussions between analysts, during the build and configuration process, rather than situations in which the users participate. They have shown how the design team seeks to understand and reason about the work of users, how well the developing system integrates with this work, and how both the work and the system may have to be altered to achieve a better fit. Now we turn to situations in which users are specifically involved in interacting with a version of the system – in this case QA (quality assurance) and integration testing. It should be noted that this is a later stage of the design, by which time the

possibilities for reconfiguration are to some extent circumscribed by earlier design decisions. The main questions posed by users centre around the fit with current working practices, the reasons and justifications for the particular design and the likely training demands to learn to use the system.

7.1 Testing With Medical Users

The following excerpts highlight many of the common types of user concerns that arise and how they are addressed. In the first, OurComp staff (Vic and Brad) are 'walking' two of the clinical A & E users (Jenny and Brian) through clinic bookings. Jenny is evidently unhappy with the fact that to go from one step to another in the workflow *'you have to go through seven screens'*. Brad, currently demonstrating the process on a computer, responds that there is a shortcut to avoid the long sequence of key strokes. Jenny replies, re-stating the problem as one where complex sequences of interaction are required for simple tasks. Brad replies *'that's the way it is'*. This is taken up by the senior OurComp analyst (Vic) who provides a fuller explanation of why the interaction proceeds as it does – for the purposes of integrating the system with NHS data collection requirements. He also describes how a series of alternative solutions to this as a problem were tried. Jenny then poses a few more questions about important functions (to a 'typical' A & E worker) asking whether they are supported by the system. Interestingly, we can see here that issues of usability may be sidelined by the requirements of integration.

Jenny – *"There's one field to fill in but you have to go through 7 screens to get to it."*

Brad – *"But you can just F7 to get to the field."*

[Jenny again voices their concern, complaining about *"having to do x clicks to carry out simple tasks"*.]

Brad – *"... that's the way it is.."*

Vic - *It's required for the A & E CDS..... A & E visits need to be counted as clinics."* – Thus mirroring other aspects of hospital work (i.e. so they have a generic form). Vic then explains why other options would not work.

Jenny – *"Can we see a day's schedule… can we tell who's had x-rays.. how do we change an appointment".*

Next Jenny suggests the system needs some practice, as it's the *first time* she's seen a clinic. Helen responds by stating that another part of the reason for the design is to 'fit in with the Trust', i.e. for the purposes of integrating processes across the Trust. Brian responds by stating what might be considered the classic problem between designing to support local practice and the constraints placed by needing to integrate processes – meeting the demands of integration is seen as a problem when it means extra effort by local users. It is also clear that the requirements for Trust wide and NHS integration are given preference over those pertaining to integration between the COTS system and existing patterns of work. Helen promises future efforts to 'streamline' things before again stating the case for integration. But then Jenny persists in describing her concerns with the new system:

Jenny – *"This is the first time I've seen a clinic, before they've never been working so I'll need to go back and practice it."*

Helen – *"You need to fit in with the Trust that's why it's like this."*

Brian – *"But it's a problem that fitting in with the Trust involves more work."*

Helen – *"Anything we can streamline we will… in the future with OurComp… and you have to realise the importance of data gathering and sharing information across the Trust."*

Jenny – *"I've been trying registration for months and have a problem of getting lost and not knowing where I am and I'm worried about how much training for our receptionists will be required."*

Vic – *"Could you drive (control the computer) and show us where you are getting lost?"*

Jenny notes that even though she has been practicing 'registration for months' she still has difficulties, and these involve 'getting lost' on the system which suggests proposed training for receptionists may be insufficient. This triggers a discussion regarding the interfaces and interaction sequences required by the new and old systems. The old system simply took the user through a series of screens where they filled them out item by item. The new system requires navigation back and forward and in and out of menus. For Jenny and Brian the new system is difficult to learn, requiring a different and more complicated pattern of interaction making it easier to get lost. Finally, Vic and Helen reiterate their comments about the need for organizational and systems integration, and that the information is required by the Trust:

Helen – *"This is a Trust wide system, you get the benefits of the information gathering of other people so you need to do this….As a teaching hospital we need to do research so we need good data…since there are no A & E people on the PAS team I'll now put you on as stuff like this is a PAS requirement so it will help you to understand and keep informed of decisions."*

Vic – *"If a patient is sent to A & E from elsewhere you won't need to fill in these details as they will have been done elsewhere so you do get benefits."*

As a 'Trust wide' system, the extra information gathered is often of benefit elsewhere, and since the hospital is a teaching hospital (required to do research) it needs 'good data'. Furthermore, users in any particular department will receive benefits from others as well as doing extra work to benefit others. Again Jenny re-focuses on the current screen noting that patients are not tagged with their 'presenting complaint' and gives an example of why she would need this information – so she can readily identify patients in need of quick attention – the *'patient…with chest complaints':*

Jenny – *"Speaking as an A & E nurse I need to know what the patient has come in with to triage…. The presenting complaint… I need to know this… it should be a mandatory field so I can look down the list and identify the patient out of 12 with chest complaints… we do this now."*

[Brad suggests you can do this with the system and moves across to show them on the computer… *"you can get the information from the whiteboard."*]

Brian – *"We don't currently work from the whiteboard, it doesn't fit with our workflow…. We have a separate triage list which we can view and re-order the patients on."*

Vic – *"We can't change this as the screen is hardwired."*

Brian – *"But we currently prioritise using the triage list… it's a fundamental facility….this really worries me."*

Brian – *"There's a few things like this that worry me from having gone through the workflows."*

Brad responds by showing Brian and Jenny that the information is recoverable from another screen in the application – the whiteboard. But Brian rejects this as not fulfilling the requisite criteria for fitting in with their work. It is not accessed as part of

their 'workflow' – they must navigate to a different screen than the one they will use for logging patients, and since the whiteboard is a static list it does not allow them to re-order (prioritise) patients as they do now. Vic explains that there is nothing they can do to allow re-ordering of lists as the screen is 'hardwired'. Brian re-states the problem and emphasizes that the problems thus far discussed are only some of the difficulties he has seen.

In this long example we can see how the analysts try to sort through different types of problems that are raised as they take the expert users through their workflow for the purposes of QA and integration testing. Often when users single out aspects of the system design that do not fit well with current work practice, produce more work for those inputting data or do not support important work activities these are described as by-products of different integration demands. These reasons may also be proffered when the analysts believe the problems to be clinically insignificant or as something that may be dealt with by training and during the domestication of the design. In the case of the discussion over need to support clinical decision making in prioritizing patients for triage technical constraints are emphasized – the screen is hardwired. However, because there is a potential clinical impact, that patients with more serious problems would not be identified, there is a greater concern to find a solution, even if it is non-optimal. Clinical impact necessitates greater concern. The solution proposed – to add a dedicated terminal to display the whiteboard – at least means the information required for the activity of prioritization will always be available, if not the means for (re)ordering the list of patients on screen.

7.2 Testing With Administrative Users

Issues of fitting new systems to working practices also surface in these next excerpts that come from discussions during integration testing for the patient administration system (PAS) team - whose leader is Christine:

Christine - *"There's a problem of doing QA'ing when you're QA'ing something but you don't actually know what you'll be getting… 'cos they don't have a PAS system in the States… it's like fitting a square peg in a round hole… in America they just go 'have you got the money – bang'.. at the end of the day it's our managerial problem so we need to start thinking of workarounds… we have to rely on the Trust when they emphasise the clinical suitability of the system."*

While analysts explain the complications for users as attributable to requirements for integration, Christine attributes them to trying to fit a US (insurance and payment) oriented system to the UK – *'it's like fitting a square peg in a round hole.'* She casts the problem as one of administration having to make the adaptations (workarounds) to fit with the system on the basis that it will fit clinical requirements. This is illustrated when Gail (PAS analyst) describes the model for patient allocation to orthopaedic consultants. The system is set up to allow doctors to monitor their lists of allocated patients with the feature that they can reject or accept them. In previous discussions users had flagged this up as a problem, since doctors are not necessarily thorough and their secretaries often prompt them on their responsibilities. Consequently, the workaround, that consultant's secretaries would also have access to these lists is introduced by Gail:

Gail – *"When a patient is allocated to an orthopaedic consultant it goes to his queue but if consultants don't answer/accept requests they also sit together on all secretaries queues' so they can monitor if appointments aren't being picked up by consultants."*

Christine – *"What about generic referrals where we usually allot to the shortest waiting list."*

This, however, is not taken as a complete solution by Christine and instead provokes her to raise further problems of the fit of the system to the work of organizing clinics. Firstly, she raises the problem that the system is not set up to allow them to allot patients to the shortest list, instead only to a specific consultant. The next comment from Christine highlights one of the major problems of implementing an integrated system when previously workers have used dedicated systems. Since the new system has a number of generic applications that dictate, for example, how resources are ordered and activities scheduled, local workflow must integrate with these. This means that users often complete some details on one screen then move to these generic applications. This means that the flow through the system appears more complicated as screens and menus are logged into and out of. Christine explains the process of learning interaction sequences with the new system to her user group by using an analogy:

"I imagine it's like the map of the tube (London Underground Trains)*… (she gestures as she speaks) you go along and sometimes you get off here, go up there, and back, to get to there… it's not a completely linear process"*

Christine's final comment (below) also takes up on some of the previous themes throughout the analysis. As noted before, the Trust project team is instructed to ensure the buy-in from the Trust users by getting them to sign off on the stages of the work. Indeed, refusal of an area to sign-off represents a major problem for the project team as this could provide a legitimate reason for users to reject the design:

Christine – *"We don't want to sign this off before we go through everything in the proper detail… we are not fully happy about accepting that training will sort out all of these problems… some of them seem like major problems."*

Just as when she did not want to sign off QAing before the system was finished, here she states her reluctance given that testing has not been conducted in 'proper detail'. This is only sticking to getting things carried out as the project schedule dictated – 'the system would be built, then it would be QA tested until users and designers were satisfied'. For analysts there is an acceptance that the idealization of design as discrete phases is only something to be worked towards, serving e.g. as a means to measure progress or concurrency. But this is not necessarily the case when users are involved. Although they may concede the need for compromise, they may use deviation from the plan as a bargaining chip. This, they entitled to do and may also be wise to do, so as to ensure they have the best design to suit their needs.

Another point to note is Christine's final comment as to whether training will solve all the difficulties encountered. While it appears inevitable that problems, particularly when deemed clinically unimportant, and technically difficult to fix, have to end up being solved by training or workarounds, it is important that users do not feel that problems are being trivialized and just driven down to a training issue. This relates to a general issue of how information is presented to users throughout the design. A lot of translation (of technical and theoretical details) between stakeholders goes on all the time. However, as the design progresses, and as users become more knowledgeable they can begin to see where explanations fall short or may become wary of repeated, 'for integration purposes',

explanations. This suggests that there is a need to communicate with them, about how integration demands will impact on the system they will interact with, earlier on in the design process.

One of the features of note in all the examples above is that misfit with current working practices can stem from a number of places, from technical and hardware issues to regulation issues that arise from integrating existing practices into new NHS or hospital-wide requirements. However, to the user they appear 'all the same', that is they all come up as problems of use with the new system. When we take into consideration the work required to learn any new system, before the benefits can be gained, one cannot help but reflect that Vic's concern, expressed so succinctly at the start of section two, is not only valid but central to successful integration.

8. DISCUSSION: TIMING IN THE ART OF INTEGRATION

As IT systems become steadily more complex and organizationally embedded the challenges of design increase. Achieving systems dependability is of crucial importance since research [e.g. 7] has already indicated how systems can be disastrously, often fatally, unsuccessful. As with the EPR system reported in this paper - progress in dependable design depends on understanding the fundamental problems that arise in attempts to build systems (or in this case configure and deploy COTS systems) involving complex organizational interactions, where different forms of integration are being attended to, in situations where organizational transformation is a key feature of design. Our interest is therefore in developing improved means of specifying, designing, assessing, deploying and maintaining complex computer-based systems in the contexts where high dependability is crucial.

8.1 Timing & Targeting Ethnographic Interventions

Researchers using ethnographic studies have stated on a number of occasions that these studies can provide an informational resource to inform the design of systems to integrate more successfully with work practices. In this case we have not studied the healthcare and administrative work to be supported by the system but instead the work developing the system. However, we believe this study provides information about how to effectively time and target ethnographic research for the purposes of design in a complex setting like this. The studies would be a variant of 'quick and dirty' ethnographies [12], which we will call 'targeted' ethnographies, where small scale studies can explicate *specific work practices related to emergent design dilemmas* at certain points in the design process, rather than to raise general design themes as was the case in the original conception of this form of inquiry.

Firstly, ethnography could be particularly useful if targeted to study current integration and 'hand-off' activities *prior to the configuration* of the COTS system. It would be useful to study the points where processes pass between one part of the organization and another – how activities are informally integrated – as a means of targeting ethnography to crucial design questions in situations where a large-scale comprehensive ethnography is not possible. This would provide better understandings of how processes mesh (or not) with one another and the work required (by talk etc.) to bring things into line. This material could form a useful resource for tackling key questions concerning how to achieve artful integration and standardization of organizational processes, by foregrounding key local practices to support in this process. For example, in the material discussed, we saw how the A & E users involved in testing raised their need to order and highlight patients in the triage list. Since the analysts did not realize the work that a triage nurse would do to the list as she received it, and since this functionality was not required in other 'clinics', the system had not been designed with this feature. Early, targeted ethnography might well have highlighted this as a specific requirement for A & E before the design was 'hard-wired'.

Secondly, problem targeted ethnography could illustrate and evaluate issues of practice to aid analysts in sorting out specific design problems during build and configuration. For example, whether the new system integrates well with work, and if not, how serious the discrepancy might be. This could aid designers in sorting out the four issues that Sommerville and colleagues list – identifying which features of work it is important to support but also areas where transformation of practice may be less problematic. As we have seen in the material from meetings between analysts during configuration, the problematic areas of design for the analysts are ones where they feel there may be a bad fit between the emerging system and the current structure of work. Are these minor usability issues, or will they create major difficulties with bad data, bottlenecks and so on? Will the problems be related to administration or will they affect clinical practice? Can training really solve them?

During configuration, analysts are often dealing with situations in which they have to 'envisage' from their knowledge and experience whether the bad fit will have serious implications, or they have to make an assessment of the 'validity' of user reports of problems because users are not present in these discussions. It is a moot point as to whether users should participate in these discussions. However, since, at this stage, there is commonly no demonstrable 'system', only a dynamic system in development, it is particularly hard for users to understand the impact of it on their work. A targeted ethnography of the work in question would provide a valuable resource to designers and developers enabling them to access the complexity of the work as it is and from this work up understandings of the impact of change. Another reason to advocate such an approach is that ethnography often highlights aspects of work that users *gloss* when they are asked what they do. Our research suggests that they are more likely to understand the interplay between the system and the details of their work when they can interact with a prototype system but unfortunately if this occurs late in design – at testing – there may already be many constraints on the possibilities for further reconfiguration. Detailed, targeted, 'quick and dirty' ethnographies where a field worker could observe the practices that were raising precisely the types of questions listed above, for a few days, could form a useful resource for analysts and users in sorting out these problems – deciding what the key activities to support were, and identifying areas where the new system might be particularly disruptive. In such situations, an ethnographer's independence from the main project team, and interest in the real time work of users might be of benefit, and might well be seen positively by the users. Although, admittedly, sensitivity to tensions and 'politics' would be key skills in managing fieldwork relations for the ethnographer.

8.2 Integrating Users in Integration Work

As we observed in material from QA and integration testing, users raise problems where the system does not fit well with existing patterns of work, or does not support important practices that, for example, allow them to highlight important patients, or sort and prioritize cases. We also saw how analysts often describe the reasons for this as to do with integrating processes across the hospital, for the needs of data collection for research and report writing, to integrate the hospital with NHS requirements, or to technically integrate the system with other technologies. That this is often the case is not in dispute. However, when users are only made aware of this need for compromise, and the effects it has on the 'system' they will interact with, this late on in design they may, as we have seen, have difficulty appreciating the argument or even respond as though they are being 'fobbed off'.

We are not saying that there is an easy way around this problem, as implementing a system like this clearly involves many compromises, and it goes straight to the heart of tricky questions about which practices should be preserved and which transformed, and whether changes to practice will have serious implications or not. However, it does seem clear that users should at least be informed of some of these issues and their possible impacts earlier on in design, preferably as they arise. If integration constraints are understood earlier then users will be more likely to realize that compromises need to be made, but carry consequential benefits, meaning that they are less likely to judge the system they are shown purely on fit with current practice, and they instead have an insight into the *biography* – a history of the development decisions – of the system.

Furthermore, it seems possible that users could be involved in some of the decision making regarding the integration of processes earlier in the project. Often analysts make decisions about how to integrate processes without users present. In these cases they can have difficulties envisaging the impacts these may have on local practices. When several possibilities exist for configuring integrated hospital wide processes it might well be useful to involve users in helping to sort out which possibility would fit best with current work practices. Involving users earlier on might better elucidate these issues, and they could be partners in deciding some of the compromises rather than the people on behalf of which compromises are made.

8.3 Timing Types of Integration Work

The requirement for achieving artful integration of the four inter-related forms discussed in this paper was one of the key design problems in this project. Trust-wide applications, like the replacement PAS system, clinic scheduling, etc. have caused some of the greatest difficulties for the project team. The COTS system already contained generic models for these processes but adapting this for the requirements of the UK NHS, this Trust and the local users has been tricky. Integrating work processes and integrating the system with the existing structure of work simultaneously – the job of configuration – took 14 months instead of the anticipated 4! Balancing the ideal of supporting the multi-fold current local practices against the need for core standardization to integrate processes, while also integrating with NHS requirements and new and legacy technologies has been fraught.

Given the benefit of hindsight the integration problem would have been fore-grounded as a major issue prior to design. The Trust may have accurately felt that they could not afford the luxury of taking a time out to work out how previously ad hoc (talk and document supported) integration would integrate electronically, and instead that they had to use the EPR project as a forcing device. However, as we have seen, trying to achieve multiple forms of integration, simultaneously, is not only very complex but means that certain requirements gain necessary priority. Most obviously this suggests that some *forms* of integration work, certainly on how to integrate current processes, and how to meet regulatory requirements, needs to be carried out *prior to procurement*; and that users should be involved in this. Not only might it encourage users to appreciate how integration may benefit others and in doing so 'get them on board' more effectively, it might also be very useful in assessing better just how or where a system fits or does not fit with the current structure of work before purchase. It is clear from the study presented here that there is great danger in procuring and deploying a COTS system as a means to achieve large scale organizational change – integration, standardization, transformation - as it is *only during the design process* that it will become apparent that the system may not be configurable in ways desired, or that the ways in which it supports integration of processes do not fit well with current organizational practices. Unfortunately if this is not discovered till the team is in the midst of the design process the possibilities for shelving the system and starting again will be severely constrained.

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