1. Introduction

Information Technology (IT) is relatively new to the British National Health Service (NHS). The NHS is learning how to use IT and information systems (IS) for the benefit of patients and for clinical processes. Rather than adopt IT governance practices from the private sector, it is seeking to develop its own best practices because of the unique socialist principles of the organization and its history. It values are deeply rooted in socialism.

The overall aim of the research proposed in this paper is to inform health informatics governance in its early stages of development in the NHS through researching deferred IT/IS methods, tools and techniques. Deferment is defined as enabling contextual, situated and semantic information design by action developers (so-called users). Deferment is proposed as relevant in the NHS because of the national and distributed structure of the organization. A deferred IT/IS infrastructure will be capable of catering for contextual and situated information needs of domain experts – clinicians.

This research concerns how to make hospital information management in the NHS adaptable to particular contexts and situations. The NHS is a public sector organization funded by the British government. We are investigating how to make Commercial Off-The-Shelf (COTS) systems adaptable to support administrative and clinical staff – the domain experts - in their roles. Laerum et al.’s [10] cross-sectional survey concluded that domain experts in healthcare, in particular doctors, made less use of electronic medical records than the systems allowed. To resolve lack of system’s usage, context and situation have become the focus of design. Yahidov [19] proposes situated aspects of decision support systems that attempt to situate the system in the problem environment.

The problem we address is how domain experts use systems in context and in particular situations. Our aim is to design software-tailoring tools for COTS to make healthcare IS adaptable to the context and situation of usage. We will apply the Deferred System’s Design (DSD) approach [11] [13] because it accounts for contextual situated and semantic IS usage. DSD makes IS independent of design decisions made by software vendors and allows domain experts to merge IS to their particular context. Our research is interdisciplinary as we draw on the Alexandrian pattern approach in architecture of enabling people affected by design to contribute directly to that solution.

The deferred perspective and its relevance for IT governance is explained in the following section. Our phenomenological approach to understanding the problem and the aims and objectives of the research are set out in section 3. The case hospital is described in section 4. We apply the DSD approach to the problem and account for its choice in sections 5 and 6. Our interim findings of the proposed three years project are discussed in section 7. We conclude by identifying the deliverables of our research and its beneficiaries.

2. IT Governance: The Deferred Perspective

Theories of organization increasingly recognized the non-planned nature of human activity and the effect of emergent organization on IT/IS [1][3]. The deferment principles reflecting emergent organization in Table 1 arise from practice in eGovernment [14]. These principles provide an alternative perspective on managing IS development projects in both public and private organizations. The principles reflect the DSD aim of bearing the objective in mind and then working in the situation to achieve it, supported by plans and situated action.

The prime focus of the DSD approach is human activity in relation to IT. The NHS is primarily a human-centered organization. IT project managers are concerned with human activity, especially focused on healthcare, rather than the IT itself. Their primary aim is to develop system analysis and development techniques that reflect the interaction between the patients and healthcare professionals, the front line staff. The proposed research is with a hospital and its COTS supplier.
Effect on DSD Development Practice

Invariably, the best practices embodied in COTS are not embodied as determined by the vendor. Outsourcing proposition for the NHS. A COTS system solutions for many organizations. COTS are a serious alternative IS requirement determination, system analysis and design, and project management principles. These are summarised as the deferment principles of analysis and design, and project management principles.

2.1 Commercial-Off-The Shelf Packages

COTS are increasingly becoming the choice for IT/IS solutions for many organizations. COTS are a serious outsourcing proposition for the NHS. A COTS system embodies best practices as determined by the vendor. Invariably, the best practices embodied in COTS are not mirrored in the organization it is implemented. This requires the vendor and purchasing organization to work closely together to tailor the COTS system to match the organisation’s processes. Such tailored COTS in particular require governance that is suited to tailored outsourced solutions.

3. THE PHENOMENOLOGY OF A PROBLEM

The research approach is outlined in this section. The domain experts are dissatisfied with IS that are bound by design decisions made by developers. Healthcare organisations like the research partner Heatherwood and Wrexham Park Hospital typify domain experts who heavily depend on contextual IS usage. Context in the NHS now encompasses the policy of evidence-based practice. The case hospital buys COTS software and then works with the vendor to tailor it to their requirements, often with mixed results.

The research problem was scoped using a phenomenological epistemology (see the classic [2]). Multiple meetings were held with domain experts to understand their problem. The Director of Clinical Services, Clinical Audits and Research Manager, and the Principal Advisor in the British Prime Minister’s Cabinet Office responsible for public service reform were consulted. The meetings were recorded as notes and interpreted by the researcher. Experts then gave their comments and confirmed the problem description. Additional information flowed between the experts and the researcher in emails and drafts of the research problem. The research document detailing the problem, aims and objectives, and the work programme has undergone five revisions, and still continues to change. This reflects the DSD philosophy of accepting change as inevitable and seeking ways of incorporating it into the development process. The approach was applied successfully to IS development in local government in the UK [14].

<table>
<thead>
<tr>
<th>Deferment Principles</th>
<th>Effect on DSD Development Practice</th>
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<tbody>
<tr>
<td>Project scoping in advance of knowing the project boundaries can lead to artificial success where the project is deemed to be successful on paper but the project's impact in minimal.</td>
<td>The professional developer has bounded rationality and limited knowledge. Setting the aim to be achieved is more important than the ability to completely define the project.</td>
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<tr>
<td>There is no such thing as being wrong, just the need to continually adjust and fine tune.</td>
<td>The professional developer is unqualified to make decisions concerning the rightness of IS or, radically, how to proceed to develop it. The development process emerges during the development. During process mapping it was necessary to add a symbol to represent a hook to back office processes. This was not thought of in the initial design stage.</td>
</tr>
<tr>
<td>How the data system works is not important.</td>
<td>System functions are not important. This radical principle allowed the developers to ignore functionality of any data systems the processes interface with. Only the system name, navigating to the appropriate screen(s) and what to do once there are recorded.</td>
</tr>
<tr>
<td>The only element that needs to be defined from a data system is the screen(s) required for the process.</td>
<td>This observation allowed developers to avoid the 'analysis paralysis' of standard development methods and concentrate on analysing services from the viewpoint of the customer.</td>
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Table 1: Deferment Principles For Project Management

A successful generic COTS package will continue to evolve after its first release and may be successfully reproduced for many generations. New functions may be added or old functions removed or restructured to enhance its ability to adapt to a new environment. This aspect is seldom reflected in the research literature in IT governance or in practice. We address this shortcoming from the perspective of domain experts enabled to undertake local development with tailoring tools. Tailoring will enable them to cope with contextual change and modify IS at run-time.

The deferred perspective on IS/IT will lead to devolved IT/IS governance, which is consistent with the management philosophy and tradition of the NHS. As in research into corporate strategy the process of IS/IT governance is the focus of our research. By taking a deferred perspective it is logical to investigate the process of IT/IS governance rather than its end product – the governance policy.

The actual development of IT governance mechanisms in the hospital is in its early stages. The Director of Research and IT Governance is seeking an alternative IS requirement determination, system analysis and design, and project management principles. These are summarised as the deferment principles of project management in Table 1 and translated in terms of their effect on DSD development practice in Table 1.
The research design is formulated to inform health informatics governance, shown in Figure 1. It can be described as deferred because the research objectives seek to provide software-tailoring tools to action developers (the so-called users). The objectives as a whole reflect the devolved aspects of the emerging IT governance policy in the NHS, and in particular in the case hospital. In turn, these objectives were determined to enable contextual and situated IS management and designs – the deferred IT governance perspective. The deferred perspectives then will lead to information management and governance thinking that reflects the values and practices of the NHS. It will aid the determination of the roles and their responsibilities and accountability in the governance structure.

3.1 Domain Experts Voice the Problem

The working problem description in this section is formulated in the words of domain experts. This provides the rich contextual perception of the problem by domain experts.

“IT has long been an under-invested area in the NHS. The average hospital spends around 0.5% of its annual budget on the running cost of IT - staff and support contracts - and around the same on purchasing new hardware and software. This 1% per annum investment compares unfavourably with large commercial organisations.

The consequence of this over the years has been heritage of poor systems with very low user satisfaction. The vast majority of these systems are to perform administrative functions - finance, payroll, library functions and counting the amount of patient activity - and very little is to support clinical staff in actually treating patients. Furthermore, the systems that do exist are unlikely to be interfaced to each other. This means that if a patient tells the hospital s/he has moved house, this is likely to be updated on the main hospital administration system, but not on the other systems such as those in pathology or radiology.

In 1998 the NHS approach to IT was revolutionized with the publication of Information for Health, the NHS’ information strategy. This committed the NHS to a 7 years, £1bn, programme that would result in every local NHS organisation reaching a minimum level of investment in Electronic Patient Records (EPR) and a national Electronic Health Record (EHR). The EPR will put clinical information online in hospital's and GP surgeries, instantly accessible by clinicians. The EHR will make core clinical information about a patient available to the right people anywhere in the country.

Clearly this scale of development is a dramatic leap forward from where the NHS is today. At present the NHS is in no position to conceive of all the ways in which the technology envisaged by the government in its information for health strategy might change the way in which health is delivered, let alone specify in detail the software that they want. The NHS' track record for buying large IT Systems is poor, witness the fiascos in Wessex and with the National HISS Programme.”

3.2 Aims and Objectives

The domain experts’ description of the problem enabled the researcher to form the aims and objectives of the research. These were then shared with domain experts for their comments and approval. Such exchanges typified the social construction of knowledge described in phenomenology [7]. Experts were made aware that their problem would be addressed by applying the DSD approach and the deferred perspective on IT governance, and it was explained to them in a ‘learning session’ conducted by the researcher using scenarios.

Our aim is to enable domain experts to adapt COTS administrative and clinical IS in the case hospital. The agreed objectives of the research are:
O1: Develop modifiable behaviour in EHR through micro-tailoring tools based on users’ subjective knowledge of its context of use in order to facilitate care pathways agreed within clinical teams, most of which are determined locally rather than nationally.
O2: Develop GUI interfaces that provide micro-tailoring tools with direct manipulation capability to tailor the systems supporting the hospital administration and clinical information to meet local clinicians (doctors and nurses) needs and national initiatives (e.g. the cancer or cardiac national service frameworks).
O3: Capture live work experiences for individual problem solving to assist clinicians and managers to better exploit data that is captured in administrative systems and EHR. For instance, identifying clusters of risk outcomes in hospitals, and enable users to design and implement appropriate run-time functions not foreseen by original designers through tailoring tools.
O4: Derive system design principles for developing tailorable technology and deferred systems for administrative systems and EHR that reflect how new entities and roles can be added or removed in the context of the systems’ use at the level of user activity that result in temporary information structures.
O5: Develop models of tailoring changes by users to administrative systems and EHR consistent with the evidence base of healthcare policy, and develop taxonomy of threatening and non-threatening users’ tailoring in terms of systems and data integrity at the database level. Empirically validate the tailoring tools and revise the developed models of user changes.
O6: Determine the trade-off between systems tailoring and data integrity and usability. The important issue is to enable dynamic system modifications without compromising the integrity and stability of the administrative and HER systems.

4. HEATHERWOOD AND WREXHAM PARK HOSPITAL NHS TRUST

The research case is Heatherwood and Wrexham Park Hospital NHS Trust. It currently buys COTS systems from a private supplier. Case inquiry and trials will be carried out in the Heatherwood and Wrexham Park Hospital. NHS Trusts and hospitals have to make radical changes, often at a fast rate, to their operations and processes, and require IT/IS to be responsive. With the cost of developing software rising, and lack of technical skills in the NHS, hospitals are relying on COTS to provide effective evidence-based healthcare, making research into system tailoring a necessity.

Tailoring by action developers is defined as reuse by redesign of COTS to adapt them to needs that were not (or could not be) anticipated by the original designers. Tailorability is needed for modifying applications and to create new ones when evolving COTS from one task domain to another (redesign). We are identifying Web-based tailoring tools or a workbench where users can interact with the system, extensible system architecture and a tailorable design layer that can be added to COTS. This forms the core of the deferred IT governance perspective.

5. THE DEFERRED SYSTEM’S DESIGN APPROACH

We briefly provide the background and context to DSD. Our understanding of IS design will improve when the gap concerning how an IS is actually used is systematically researched. IS design needs to be active rather than reflective. By reflective is meant that the design and implementation is separated from actual usage. Whereas active means that design and implementation happens during the usage of IS. Active design is done by action developers and reflective design is done by reflective designers [13].

The current practice in the case hospital is to separate design from implementation, that is it is reflective design. This is true of the IS literature on structured systems development [19] and object-oriented development [9]. The reason for this separation is historical. Technology use in industry is itself associated with the history of industrial design. Systems analysis as a set of techniques and tools for complex problem-solving, focusing on broad strategic and policy questions, has its origins in military, industrial and engineering problem resolution [4] that separated thinking of the context from acting in the context. The result of this practice is contextless, inflexible, and cultureless IS. An issue for researchers is how the phenomenological aspects of IS [1] [2] [7] [8] [17] can be reflected in IS design, and particularly to the way that IS are used as a mode of social interaction. This alternative thinking and practices includes context and situation in IS design as exemplified by [1] [15].

DSD seeks to merge design and implementation at run-time through the user interface and views domain experts as action developers. Thus DSD is run-time system functionality that is determined through deferred design decisions (DDD) [11] and deferment point analysis (DPA) during the development process.

DSD is active IS development in which IS is designed during social action, in-the-situation and not necessarily for an optimal and efficient future state. It does not pre-define data inputs, hard-wired systems functionality, and outputs. It is essentially non-interventionist. The de facto run-time state of the IS is designed and implemented in real-time and in context through end-user tailoring by domain experts (action developers) involved in the practice and administration of healthcare.
6. DESIGNING FOR CONTEXT AND SITUATION

The deferred perspective on IT governance focuses on the development, deployment and management of IT/IS tools. A tool is a ‘wholly constructed expression of both knowledge and values.’ [6]. There has been a paucity of such tools in IS. Deferment caters for changing and emerging information and knowledge design through tailoring tools. We are investigating Alexandrian patterns for their potential to model application domain objects and relevant tools. DSD is similar to Alexandrian architectural approach:

“A building or town is given its character, especially, by those events that keep on happening there most often.” (Alexander, 1979, pp.65-66).

The ‘events’ are determined by people or inhabitants, not architects. Similarly, in DSD the aim is to enable people who use software to determine its functionality at run-time. It is these events that IT/IS tools need to support, and the mechanism for that is Deferred Design Decisions.

6.1 Deferred Design Decisions

The Alexandrian philosophy of involving inhabitants of a buildings in its design via the didactic mechanism of patterns is consistent with Deferred Design Decisions (DDD) in software design. Enabling domain experts to actively design IS has not been achievable. DDD is the mechanism that enables domain experts to take system design decisions in context. This research proposes to apply the pattern language approach to develop models of the application domain, building on previous work on a requirements elicitation tool that implements DDD [12].

DSD incorporates the temporal dimension in COTS. As clinical diagnosis practices change with new research findings, the need for relevant information to make a diagnosis changes too. Such context can be reflected in COTS through DDD and object-oriented technology is suitable for this purpose [16].

7. INTERIM RESULTS

Patterns help to describe domains, processes and tasks, and are aiding in early system definition and conceptual design. These patterns are a particularly useful communications medium. We will define a pattern as structured text, diagrams and some code [5].

Various administrative and clinical tasks have been identified for support via DDD. These include seeking specific information from patient records, viewing results from new tests or investigations, obtain data on treatment procedures, or collecting patient information for writing referral and discharge reports.

7.1 Implementing DDD

The new developments in the semantic Web [18] provide further opportunities for developing deferred IT governance mechanisms. The problem of improving information sharing on the Web is the goal of the W3C. Its design principles are formulated to enable the design of Web-based applications that result in information sharing across the Internet, intranets and extranets. The design principles that the Web and Web applications should enable are interoperability, evolution, and decentralization [18].

The implementation of DDD will be in XML and tailoring technology. The reason for choosing XML as an integrative language is that current Electronic Data Interchange (EDI) standards do not adequately address the needs of the British Government’s e-GIF stipulations.

Component software is one of the most promising current approaches to developing evolutionary software. It provides a level of abstraction that reflects human activity and it is complimentary to DSD.

7.2 XML and Tailoring

Our initial coding reveals that XML has several benefits over other integrative languages. The benefits that enable the development of deferred IT/IS tools are listed in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Deferred Aspects of XML</th>
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<tbody>
<tr>
<td>XML can provide multiple views of the same data</td>
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<tr>
<td>XML is extensible</td>
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<tr>
<td>XML separates content from style</td>
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<tr>
<td>XML facilitates semantic dimension to Web documents</td>
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<td>XML provides enhanced data management</td>
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<tr>
<td>XML enables more meaningful searches</td>
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<tr>
<td>XML is more human readable</td>
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<tr>
<td>XML eases the way for local computations and manipulation of data</td>
</tr>
<tr>
<td>XML can integrate data from multiple, disparate sources</td>
</tr>
<tr>
<td>XML compresses easily</td>
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<tr>
<td>XML frees server from processing load</td>
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</table>

An example Alexandrian pattern implementable in XML is a clinical letter. A clinical letter for referral and discharge is formatted using paragraphs, headings and tables and its visual layout is vital for human interpretation. XML and its associated style sheets enable the context of clinical letters to be processed. It enables both human readability (layout) and machine processing.
The research will result in further deliverables that will provide deferred mechanisms for IT governance. These will encompass the following deliverables: design and develop graphical users interfaces that provide micro-tailoring tools with direct manipulation capability for the administrative and EHR systems (outcome: GUI for administrative and EHR). Develop models of object-oriented system architecture that exhibit deferred system behaviour and implement these models. (Outcome: object models of deferment). Design and develop micro-tailoring tools for administrators and clinicians (outcomes: tailoring tools). Empirically validate tailoring tools and models of user tailoring, and assess the trade-off between user tailoring and systems integrity (outcomes: empirically validated models of user changes).

8. CONCLUSIONS AND FURTHER RESEARCH

IT governance within the NHS is in its developmental stages and the organization is seeking IT governance mechanisms that support contextual and situational information management. The organization’s values and beliefs mean that it cannot deploy existing IT governance practices from profit-making business. Its deeply rooted socialist principles, healthcare philosophy and national structure have resulted in a need for dedicated mechanisms and philosophy.

The outcomes of the research will benefit Heatherwood and Wexham Park Hospital and its COTS supplier. The findings will generally be beneficial to the public and private healthcare sector in the UK. We aim to build a knowledge base of how administrative and clinical users use information and reduce maintenance activity on IS (currently 70-80% of IS costs) by incorporating emerging information needs.

The remainder of the research programme detailed in section 3 needs to be completed. The interim results are meager to make meaningful generalizations. The potential generalizations will be significant for developing evolutionary and adaptable COTS and for informing further research.

True to phenomenology we end with domain experts' perception of the research: "The NHS needs an approach which will allow it to specify the core, get the technology right and grow the systems as its users develop their understanding and the sophistication of their needs. Large sums of tax-payers money will be spent by the NHS over the next 4 years. The development of DSD would help them spend it wisely. A goal of the research is to map out the territory of tailorable application development to determine how well evolutionary development is supported in applications and to identify areas that can be further improved."

References

http://www.w3c.org/2001/sw/Activity.

Situated DSS. Proceedings of the 35th Hawaii 
International Conference on System Sciences. Hawaii, 
USA.

Fundamentals of a Discipline of Computer Program 
and System Design. New York, Yourdon Press.