Design Research: The Deferred Actions of the design of the National electronic Library of Infection (NeLI)

Nandish V Patel
Brunel Organization and Systems
Design Centre [BOSdc], Brunel
Business School Brunel University,
Uxbridge, UB8 3PH U.K.

nandish.patel@brunel.ac.uk

Patty Kostkova
City ehealth Research Centre (CeRC)
City University, Northampton Square,
London, EC1V 0HB, UK

patty@soi.city.ac.uk

ABSTRACT

Design research is concerned with developing knowledge of the design process. However, do theoretical system design theories meet the needs of system development in the real world setting? Are technical decisions made and justified on according to system theories or do social, political and financial factors prevail? We investigated the evolution of technical design, specification and development milestones of the National electronic Library of Infection (NeLI) in the UK, one of the major government initiatives in the area of infectious diseases. By investigating project documentation, internal and formal specifications, informal email discussions where key technical decisions we made, we found out that the digital library design was rather unsystematic. We applied Purao's standard descriptive model of design to understand the design of NeLI and compare the design process with the Theory of Deferred Action, which argues that rather than design being systematic it is subject to deferred action. In this paper, we will discuss the preliminary findings of this a work-in-progress project

Categories and Subject Descriptors

Healthcare Digital Libraries, Infectious Diseases, Technical design, Systems design, Search engines, Deferred Design
.

Keywords

Digital Library, Health, System Architecture, Theory of Deferred Action

1. INTRODUCTION

System design is a complex process with technical, social, political and financial factors.

In this paper, we will look at a general system design model, Purao's model, and test it in on the development process of a real-world digital library, the National electronic Library of Infection (NeLI, www.neli.org.uk) being developed in the UK. Our focus is on the synthetic product as design research. In design research knowledge is built through making products – artifacts – and their evaluation.

In NeLI development, the technical design decisions, service specification and development milestones were subject to many social, political, personal and financial factors rather than cleanly following Purao's system design theory. The Digital Library portal development (the DL is up an running since 2000 but subject to ongoing improvements) did not implement the pre-defined services to support the core data management and search functionality and enhanced them by DL research features (such as support for preservation, multimedia search, user-centered design and following one of the DL theoretical models) but was rather subject to many non-systematic changes and deferred actions that we have discovered by investigating the project documentations and informal email discussions.

We aimed to examine the NeLI design process to contribute knowledge of design in terms of deferred action. The aim was to examine the nature of design and how we design. The rest of the paper is organized as follows; the next section introduces the deferred design theory and the Purao's model for the design cycle. Section 3 discusses the NeLI design development, section 4 Analyses that from the development cycle perspective. Section 5 discusses the revealed deferred actions in the project design and section 6 concludes.

2. THEORY OF DEFFERED ACTION

Studies of the design of IS have resulted in the Theory of Deferred Action (ToDA). 'Deferred action is defined as action taken when formalized knowledge cannot be enacted because of lack of requisite information and knowledge' [1]. ToDA is a set of theoretical design constructs, design types and design principles. It reveals that the design process has elements of deferment [2]. Deferred action was observed in knowledge work in a marine insurance company [1]. Scoping of a systems development project contained deferred action [3].

Since deferred action occurs in knowledge work and systems development is knowledge work too, we hypothesised that DA occurred in the design of NeLI.

By applying Purao's model [4] (illustrated on Figure 1) of reasoning in design, we want to learn (a) whether the findings of previous work on deferred action can be repeated in NeLI, (b) whether any new findings can be obtained and (c) make generalisations on such findings that apply to design of systems in general.
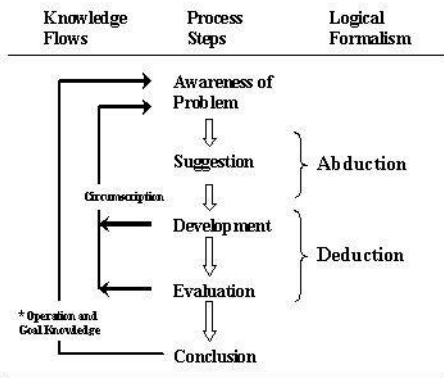
Figure 1: Reasoning in the Design cycle

3. NeLI DESIGN

NeLI is the National electronic Library of Infection (www.neli.org.uk) being developed by the CeRC centre, City University for the professionals in the NHS. The Internet Digital Library is the key portal to evidence0based information on prevention, treatment and investigation of infection diseases for the professionals around infection – clinicians, GPs, Environment Health Officers, Communicable Disease Control Nurses, CCDCs, public health professionals and others. The library is the Infection Specialist Library of the National electronic Library for Health (NeLH) [5]. The project started in 2000 and developed throughout five years on the technical, political and organization/management levels. For the purpose of this paper, we will focus on the technical development of NeLI, not the entire NeLH project that will be only discussed in relevance to the NeLI design.

3.1 Project Aim and Consultation

The White Paper on the NeLH library [5] defined the aim of the project:

The three major goals of the NeLH are [6]:
- *To provide health care professionals and the public with knowledge and know-how to support health care related decisions*
- *To provide easy access to best current knowledge and know-how on the Internet*
- *To improve health and health care, clinical practice and patient choice.*

However, there were ongoing discussions about the actual aim, project structure, management and policies for consultation that are well demonstrated by the following email discussion about NeLCD sharing its Project Plan document with the Steering Group prior to approval by the NeLH team (April 2000):

"whoops I did not know that ours would have to go through a process of approval -I have already shared the draft - so I hope to get some helpful feedback from the group I can always claim to be following the dictum of a wise Public Health Physician I once met in Oxford - "Never ask for permission, just ask for

forgiveness" prize to the person who gets the correct attribution." (by X)

Reply by the NeLH team leader:
"If X won't propose his plan as a template, I will. It has all the information we want in a logical, easy- to-follow structure. What more do we need?"

3.2 Centralised versus Distributed Service

Initially, there was a long discussion about the distributed structure of the service design and data exchange format among all specialist libraries. The agreed standard was XML and the NeLI team developed an appropriate DTD, based on Dublin core definition.

Compatibility and interpretability issues were on the agenda at the early stage of the distributed development (internal email by NeLH team member):

"NeLH needs to incorporate DH material, so we have to be compatible with their systems. Ultimately it would be a shame if we became incompatible with ourselves. When is the next group meeting?"

3.2.1 XML standard adoption
Internal email exchange reveals the discussion on XML standards by two senior project leads in March 2000.

"Agree re XML
We had already been considering that XML would make the best standard for developing the NEL Communicable Disease."

Reply: "lets go for it" (the project lead)

Another email extract by a NeLI team member:

"Why XML?"

HTML is a markup language, that means it defines a set of markup rules and limits for displaying data by a Web browser. The main drawback of HTML is the inability to define the meaning of the data content and to separate the content from style."
"Data management"
In addition to separating the content from style, XML-defined objects could be used as a middle format for viewing data from multiple sources, for transactional processing or for supporting a data exchange in an "agreed" format (that will be of a particular need in VBLs). However, there is no restriction for the actual data management and storage: it could be a traditional DBMS (e.g., Oracle), or a light-weight Web database (e.g., Microsoft SQL server) or XML files or any other data formats."

3.2.2 XML/DTS specification

The NeLI team formalized these.

"Figure 1 illustrates the NeLH framework. NeLCD stands for the National electronic Library for Communicable Disease, NeLC is the National electronic Library for Cancers, and the NeLPC is the National electronic Library for Primary Care."
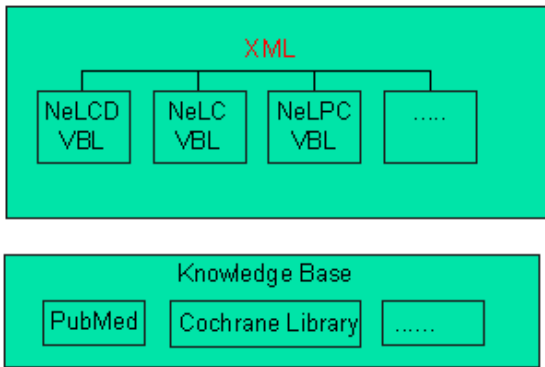
Figure 2: The NeLH Structure

Sample XML developed for data exchange by NeLI team:

```
<?xml version=”1.0”?>
<?xml-stylesheet type=”text/xsl href=”document.xsl”?>

<!DOCTYPE document SYSTEM ”document.dtd”>
<document
        id = ”1”
        title =”PHLS Meningoccocal Infection Fact Sheet”
        category = ”Prevention”
        publication_type = ”Fact_Sheet”
        text = ”http://www.phls.co.uk/advice/mening.htm”>
        <keyword>
                meningococcal disease
        </keyword>
        <keyword>
                meningitis
        </keyword>
        <qualitytag
                evidence = ”Unspecified”>
                <sourcesite>
                        PHLS
                </sourcesite>
                <timestamp
                        publication = ”20/04/2000”
                        posting = ”23/05/2000”
                        expiring = ”01/01/2000”>
                </timestamp>
        </qualitytag>
</document>
```

3.2.3 A Star Topology

In 2002, NeLI team developed the structure for the distributed communication using a star topology network

"We are investigating a star topology, that is, a VBL processing a search will contact the NeLH server, which acts as a mediator, to obtain search results from all other VBLs." [7].
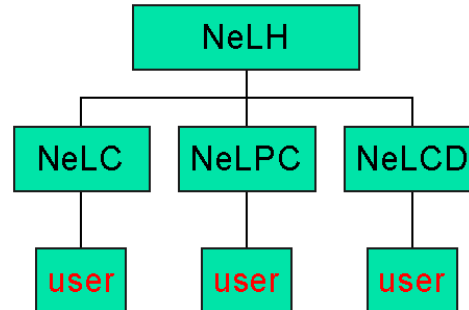
3.3 Search

3.3.1 Initial discussions

There was a plan to search NeLI, approved sites and whole Internet from a specifically designed search function.

"For the moment no we may end up with UK approved sites and UK and abroad approved sites which would pick up CDC, LCDC etc" (internal email from 7/3/2005)

Internally, NeLI search engine was a developed using CGI scripts.

3.3.2 Agent-based Search

In 2002, an agent architecture using Intelligent Agents for search and personalization was specified.
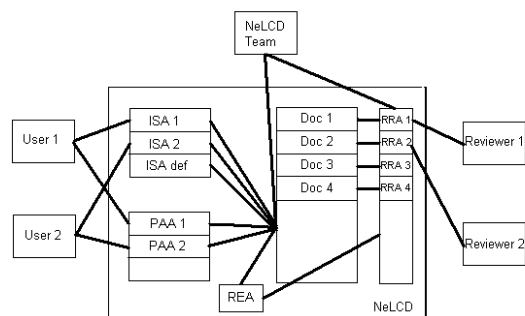

Figure 4: Agents in NeLI

"The primary goal of the library to provide a single portal for searching for an up-to-date medical information. Intelligent Search Agents (ISA) are used to provide the search-related functionality.

Tasks

- *Presenting users with a user-friendly adaptive interface to define a query for searching medical information in the library.*

- *Performing the searching functionality according to the given criteria.*

- *Displaying the search results according to user given criteria.*

Number

There is an ISA for each registered user to allow the customisation of the interface and the search. In addition, as registration is not compulsory, there is a default ISA providing standard search and presenting default interface to non-registered users." [7]

3.3.3 Current Search

Built-in Lotus R6 search engine is used for performance reasons while the agents play a pivotal role in the automated documents review process.

3.4 Indexing and Data Structures

3.4.1 Initial Indexing Design

Initially, the design of documents in the library was very simple including only the following fields [9]:

ID
Title
Author
Source
Keywords
Category
Quality tag

Keywords for indexing included only [9]:
Bacteria [B3]
Viruses [B4]
Bacteria Infections and Mycoses [C1]
Virus Diseases [C2]
Parasitic Diseases [C3]
Anti-infective Agents [D20]

3.4.2 Indexing in new NeLI design

The current library uses Dublin Core extended to allow the quality tagging (discussed below) is the document definition and MESH as the underlying indexing scheme:

"The library metadata structure is the Dublin Core (Table 1) and the chosen ontology is the MESH indexing scheme. As discussed above, MESH terms are used for indexing the documents in the library (DC field "Subject").

The second area where we use MESH in NeLI is presenting a pruned MESH tree as a controlled vocabulary for user search input. The pruning was performed to reduce the number of the keywords and reflect the needs of the communicable disease domain. Therefore, MESH sub-trees B "Organism", C "Diseases" and parts of the sub-tree D "Chemicals and Drugs" were originally selected; the number of levels included was chosen according to the frequency of each particular term. Typically, the pruning process included terms up to the 3rd or 4th MESH tree level."

In addition, in the new NeLH CMS system a subject-based tree has been implemented for every SLs. Move from MESH to SNOMED CT has been announced by the central team.

3.4.3 Semantic Indexing and Ontology

Further work on the semantic representation (combining MESH keywords and public health keywords developed by the PH Observatory in Cambridge) and ontological mapping is being carried out [8] but this has not been fully implemented to allow evaluation.

3.5 Quality Assessment

3.5.1 Initial discussions

Central NeLH team view (from internal emails):

"Are we (VBLs) content providers to a larger organization (NeLH) in which case we recommend a special collection to the 'Library' or are we summarizing information and placing a value on its evidence and relevance? The former is no doubt an easier process. The latter, which NeLD undertook in pilot phase is very time consuming and required appraisal to the level of a CAT. This has implications as to the size of any VBL collection (ie.how inclusive) and its breadth. NHSDoL, arguably the first VBL, does subject its material to a rating scale, 1-5 stars based on DISCERN."

Initial discussions form inter mail by the NeLI team email from March 2003 reveal the uncertainty in defining the value added feature:

"Users (GPs, patients, PH etc) can define quality of information at several levels:
- "medical quality" of searched information (e.g., RCT, well-known journal review, ...)
- "quality of information" (CAT, review, guidance, full papers)
- "technical quality" (e.g., link connection)
- etc.
Hope, it makes sense. :-)"

3.5.2 NeLI Design

"One of the crucial requirement of the National electronic Library for Health (NeLH) is providing the best available evidence and quality-tagged medical information to all user groups. By the term "quality" we mean information on the level of evidence, the source of the evidence, consistency, completeness, reliability and "up-to-date-ness". This will distinguish the NeLH from many other existing medical sites which typically offer comprehensive search for documents available on the Internet without giving the user an insight into the level of evidence and quality of the presented information." (from internal technical documentation from 2000)[9].

The "**Quality Tag"** consisted of [9]:
Levels of Evidence
Time Stamp
Source Site

3.5.3 Cross- Library Quality Assessment

This was initially an issues the quality was the value added feature. The following internal email reveals the initial thoughts on this subject.

"Cross Library QA - totally agree that we should discuss this - I posted a while ago about the problems that will arise if we don't use common methods - a paper/guideline could be reported as Level X evidence on one library and level Y on another, leading to confusion. This could be due to different interpretations, or using different scales. I am coming to think that rather than use a scale - in which case we will have to all use the same one and provide access to its meaning, we

3.5.4 Reviewer's Assessment

Later on NeLI developed a brief form for Reviewers Assessment (formerly Bottom Line) summarizing the key questions on methodological soundness and quality to be assigned to each document.

Bottom line

1) Short summary/abstract
*   Medline/NeLCD to provide*

2) What question is the document addressing? Short 1 or 2 sentences

3) What type of study is it?   (review, meta analysis etc.)

4) Are the methods valid, appropriate?   YES/NO

5) Are the results/recommendations reliable? Short 1 or 2 sentences

6) Are there any major problems and biases? Short 1 or 2 sentences

7) Are there any other important/relevant studies which confirm/contradict   Please provide these

Signed

PHLS Advisory Committee

To achieve objectivity, these were based on more comprehensible checklist:

3.5.4.1   I. METHODOLOGICAL ISSUES
3.5.4.1.1.1.1   For RESEARCH STUDIES
Did the article address a focused issue?
Was the aim/research question clearly described?
Is the choice of the study design appropriate to perusal of this issue?
How authors chose options and outcomes?
Did authors consider all or most effective practice options?
Was the sampling strategy clearly described and justified?
Was sampling method described?
………………………..

Figure 5: Check List for filling in document appraisal "Bottom Lines"

3.5.5 Current Quality Appraisal in NeLI

NeLI still uses the RA-base quality appraisal as these proved to be useful and demanded by users in our survey from 2004. An online forum to discuss controversial issues has developed online but has not been used extensively. Further research and evaluation will show what is the reason of the lack of interest in commenting in the forum.

3.6 Evaluation

Web log based evaluations has been carried out in 2003 and 2004 to investigate user online behaviour, search terms and browse and search preferences. It was the following web log study that revealed that most users prefer A-Z browsing [10,11]

User satisfaction survey carried out in summer 2004 revealed that users are happy with the quality of the information and would recommend the site to a friend. Users were in general satisfaction with the service; however, there were minor layout issues we address as well as the issue of rather simplistic graphical design that was overcome by the new version of the library.

As extensive user satisfaction with the digital library and evaluation of the new technical solution is now in progress, unfortunately, not significant number of users have taken in this study yet to allow us to draw any major conclusion about the usability and user-centred design improvements to be made to the digital library.

4. Analysis

In this key section we will analyse on NeLI technical features, specification decisions, and project milestones according to the Purao's theory and will reveal number of deferred actions. As this is a work-in-progress, we will discuss the preliminary findings.

Project Aims and Consultations, briefly mentioned in section 3.1, only illustrate the discussions in the initial months of the NeLH/NeLI project to set the scene for the coming core sections on various technical features (sections 3.2. -3.6). Analysing the Aims is not in the scope of this DL system design paper.

4.1 Centralised versus Distributed Service

The initial design for distributed solution with dynamic cross searching was abandon and a centralized RMS server is being implemented. This compares well with Purao's circumscription in the abduction process.

4.2 Search

After initial attempts to search other sites and cross-search other VBLs/SLs, the development focussed on improving the local search engine by enhancing it with free-text, pull-down menus. This is characteristic of deferred action. In this case, an original design proposal was abandoned. However, one of the most surprising revelation when evaluating the library was that users prefer browsing to keyword-based searching and to free-text searching, as revealed by the web log analysis [11].

4.3 Indexing and Data Structures

There has been long process towards standards based on DC for document representation (catalogue cards) and MESH for indexing, however, for user access purposes, a pruned MESH consisting of the most commonly used terms extended with PH terms seem adequate. Design decision in this case is based on contextual understanding of users, it concurs well with deferred action being a consequence of contextually shared knowledge.

4.4 Quality Assessment

There has been a clear clarification that evidence assessment is the value-added feature, however, lack of interest in providing RAs and contribution to the discussion forum might have had suability reasons or there is a time issue. This will be further evaluated, however, it is clear from the user response that the

quality appraisal is an important feature of the library that would otherwise regress to a database of links to medical documents.

4.5 Evaluation

Ongoing evaluation using Web logs and surveys supported the course of the project, major study is about to be carried out.

5. DISCUSSION

The NeLI design process is indicative of the deferred actions of designers. It can be described in terms of deferred action within the stages set out in Purao's model. We observe that abduction in the awareness of the problem stage is not a discrete and obvious event. Awareness of the problem, or problem definition, is surfacing and emerging, which is consistent with the DRASS matrix's emergence dimension [1]. Similarly, the suggestion stage, or problem resolution, is not obvious. NeLI designers deliberated on various standards and Web technologies, and were able to make some design decisions only when contextual features become known.

A significant difference between Purao's model and ToDA concerns Purao's development and evaluation stages. These are presented as discrete stages with circumscription. Whilst Purao's model describes development as a deductive process NeLI designers data reveals abduction in the development stage too. Deduction can be clearly observed in a notation language. These differences confirm deferred action in the NeLI design process.

The analysis work, despite being in its preliminary stages, has revealed interesting results, however, further research is needed to better identify and analyse the deferred actions in the key design stages of NeLI digital library.

6. CONCLUSION

The social context of development gives rise to deferred action within which abduction and deduction can be observed in the design process of digital libraries. The design process has a social context which determines how design is actually done compared with prescriptive models of design or even models like Purao's that explain design as a cognitive form.

The socially contained design process has elements of deferment. Deferred action occurs when requisite formal knowledge is incapable of providing obvious direction on action to be taken. In such cases, designers defer decisions while deliberating next moves.

In this paper, we have discussed preliminary analysis results of the technical development of the National electronic Library of Infection (NeLI) and demonstrated the occurrences of a number of deferred actions changing the initial design. Further investigation is needed to better understand the reasons behind these deferred actions that lead, step-by-step, to the current NeLI version providing service to over 2000 unique users a month.

7. REFERENCES

[1] Patel N V. Sustainable systems: strengthening knowledge management systems with deferred action. *Int. J. Information Technology and Management,* 4 (4) 344-365, 2005

[2] Patel N V. Deferred Systems: Deferring the Design Process and Systems. *Journal of Applied Systems Studies.* 5 (1), 2005

[3] Harris H J and Patel N V. A Narrative Analysis of Information System Development in a Local Government Organisation: Conversations Reflecting Deferred System's Design. *ACM Conference on Object-Oriented Programming, Systems, Languages, and Application. (OOPSLA 2001) International Workshop on Semantics of Enterprise Integration*, October 14-18, Tampa Bay. Florida, 2001

[4] Purao, S. Design Research in the Technology of Information Systems: Truth or Dare. GSU Department of CIS Working Paper. Atlanta, 2002

[5] J.A. Muir Gray, S de Lustignan. *National electronic Library for Health (NeLH).* BMJ, **319**, 1476-1479, 1999

[6] J.R. Weinberg, J. Mani-Saada, K. Smith. The National electronic Library for Communicable Disease (NeLCD). Poster. *FIS Conference*, UK, (2000)

[7] P. Kostkova et al. Agent-Based Up-to-date Data Management in National electronic Library for Communicable Disease. In SI: "Applications of intelligent agents in health care", J. Nealon, T. Moreno Ed, in *Whitestein Series in Software Agent Technologies*, pages 103-122 , 2003

[8] P. Kostkova, A. Kumar, A. Roy, J. Weinberg, G. Madle, E. Carson: Ontological Principles of Disease Management from Public Health Perspective: a Tuberculosis Case Study. *In the Proceedings of the 2nd Health digital Library workshop (HDL 2004)*, ECDL 2004, Bath, September 2004

[9] P. Kostkova, J. Weinberg. NeLCD Data Representation . Internal project technical documentation, July 2000

[10] http://www.student.city.ac.uk/~ee883/Weblogs_ Report_Top.htm

[11] http://www.staff.city.ac.uk/~jane/WeblogsReport/ Weblogs2004.htm