# *Interaction Modelling for Digital Libraries*

Ann Blandford, Nick Bryan-Kinns & Harold Thimbleby
Middlesex University
March 2000

## Abstract

We report on the background to ongoing work on modelling interactions in multi-agent systems, as applied specifically to the design and evaluation of digital libraries. This work is at an early stage of development; the aims of the project are to develop and test a notation and modelling technique that support reasoning about the quality of the interaction between users and devices, using digital libraries as a test domain.

## Introduction

One of the major challenges for Human-Computer Interaction (HCI) is to deliver tools and techniques that can be used to improve the usability of particular classes of devices. HCI techniques lag behind technology, so that we currently have a reasonable battery of tools that can be applied to evaluate word processors or devices that are designed to support well-defined tasks, but our understanding of the use and usability of novel technologies is comparatively weak. Without the development of relevant theory, the design of novel technologies will remain a largely craft-based skill.

The user's experience of working with any technology – whether or not the user achieves interesting goals in a satisfying way – depends on a variety of design factors that need to be taken into account together. An integrating framework that accommodates user, device, domain and more general context-of-use concerns is needed. Interaction Framework (Barnard & Harrison, 1989; Blandford *et al*, 1995) has the potential to fill this role. The focus of this project is on usability of Digital Libraries, which present a range of usability challenges, and are likely to become increasingly important over the foreseeable future. When compared to the overall provision of the World Wide Web, they support a relatively well defined set of user tasks, and are typically designed with a particular user population in mind. In particular, as structured repositories of digital documents that are accessed both locally and over networks, factors that affect usability include:

- the information structure,
- network response time and the patterns of communication between users and computer systems,
- the content types of documents and the ways individual documents can be accessed, and
- the context that the user is working in.

The focus of this project is on working with all users of a library, including developers and librarians as well as end-users. Various libraries are participating in this work.

The Faculty of Health Studies, which has sites at several hospitals in the North Thames region, is a member of a consortium that has obtained funding to set up an Electronic Library in Medicine. This will make publications available to staff, students and practitioners both at a central location (a new library on the Whittington Hospital site that provides both traditional and electronic documents) and via client computers located in wards and health centres. Important questions here clearly include how practitioners integrate library access with other aspects of the work and professional updating, and how relevant information can be made available in a timely manner.

Across Middlesex University, the Hybrid Library Project is taking the approach of complementing existing library provision with appropriate electronic resources for students and staff across all disciplines. This project is concerned with developing appropriate infrastructure to deliver both traditional and electronic library services to all staff and students across the University.

While these libraries will be the main focus for user studies – in order to understand better how people work with library-based material in a variety of situations – to support design activity, we are also working with the developers of the New Zealand Digital Library (NZDL; Witten, Nevill-Manning, McNab & Cunningham, 1998). The source code for this library has been made available to us so that we can develop and test alternative interface designs.

## Aims of the project

The overall aims of this project are two-fold. The primary aim is to develop and test the Interaction Framework as an approach to usability modelling that focuses on the interaction as an entity in its own right. One important feature of this approach is its role as an integrating framework, accommodating insights from other sources so that interrelationships and interferences between different aspects of the design can be reasoned about without bias towards a particular perspective. A second important feature is its focus on properties of the interaction, allowing the designer / analyst to reason about non-functional interactional requirements within design.

Since the chosen domain of application is that of digital libraries, a secondary aim is to give a model-based account of ways in which digital libraries may be made more usable and useful. In this work a broad range of concerns, including

interface design, features of the network configuration, an understanding of users' tasks and the contexts within which they are working and the properties of different media, will be taken into account.

## Background

There are two important aspects to the background of this project. The first is past work on the Interaction Framework that will be developed further within the project; the second is past work on usability of digital libraries.

### *Interaction Framework*

Interaction Framework was originally proposed as an integrating approach that focuses on the interaction between users and devices, treating both as having equally important (but different) roles within the interaction. By rigorously describing abstract properties of interactions, it becomes possible to reason about how user properties and particular design decisions influence each other to yield more or less satisfactory interactions. For example, Harrison, Blandford & Barnard (1994) demonstrate how a notion of 'user freedom' can be used to generate requirements on a device design, while Barnard, Blandford & Harrison (1994) give an example of breakdowns in the interaction that can be accounted for by relating user properties and device design. IF is used in conjunction with other theory-based or empirical techniques; that is, it provides an integrating framework that accommodates insights from other approaches.

Interaction Framework provides a way of describing interactions in terms of event traces, where an interactional event involves some form of communication between agents (users or devices). It can be used both descriptively – to describe an interaction that has already happened and reason about properties of that interaction – and prescriptively – to specify requirements on the design of the interaction. Blandford *et al* (1995) illustrated both of these modes of use for a limited set of requirements for a multi-agent system (an audio-visual awareness server). This preliminary work serves as a proof of concept indicating that the approach is viable, but needs further development to accommodate the range of issues that are of concern for digital libraries. For example, as well as dealing with temporal ordering we also need to be able to reason about more precise timing requirements and the 'pace' (Dix, 1992) of the interaction. Similarly, as well as describing communication via different channels (e.g. visual / auditory) we also need to be able to reason about the properties of different information forms (e.g. text / graphics / animations). The existing IF notation incorporates a representation of task structures that has similar properties to conventional hierarchical task descriptions (e.g. HTA: Annett & Duncan, 1967) but it does not include a way of representing other features of the domain and task context. Thus, IF has the core properties to support reasoning about interaction design but it requires further development to support analysis of interactions – such as those between a user and a digital library—where timing, modality and context are central to usability.

### *Digital libraries*

There is high investment in digital libraries, much of it focused on the structuring and management of collections, on technical concerns and on issues raised by internationalisation (see Lesk, 1997, or ACM, 1998, for a broad overview of research areas that have an impact on the development of Digital Libraries). Digital libraries provide a challenging domain of application for any usability-oriented modelling approach, since little work has been done on use and usability. Examples of work in this area include that of Theng & Thimbleby (1998), who address the question of 'lostness' in Digital Libraries, focusing on the local interaction between a single user and a library as accessed through a single machine. In another direction, Eason, Yu & Harker (2000) discuss use as being determined by perceived usefulness of the library. However, the questions of how the information structure, network infrastructure, interaction design and context of use interrelate, and how HCI modelling can be used to guide design and redesign, have received little attention.

To illustrate the problem, we consider here one example of a non-functional requirement that an ideal digital library would satisfy: that users should be able to find interesting documents through 'serendipity', and be able to quickly assess how interesting they are. Within traditional libraries, 'serendipity' often occurs when a user is looking for a particular book and happens to notice another interesting title on a nearby shelf. They might pick it up and check the contents page or flick through it to see if it still looks interesting. In a networked digital environment, the provision of such a capability would impose requirements on, for example:

- the information structure (the way documents are categorised and displayed),
- network response time (which determines how easy is it for the user to quickly find out more about a document),
- the way individual documents can be accessed (does the user have to download the entire document to view it? what alternative viewing mechanisms are provided?).

A device might be designed to support serendipity through careful design of these features. Alternatively, the use of a 'recommender' system, such as those used by some internet book sellers, or a 'personal librarian agent' might enable the computer system to actively support a kind of serendipity, based on document selections made by previous users. The same abstract interaction requirement can be implemented in alternative ways.

Other interaction requirements can be identified; for example, that the library should support *familiarisation* (that users can rapidly gain an overall impression of what kinds of material are available and of how those materials are structured); that it should support what Hall (1997) calls the *'IKIWISI principle'*: that users may not know exactly what they want, but that 'I'll Know It When I See It'; and that interaction trajectories should be *'canonical'* (Blandford et al, 1995) – that is, as efficient as possible.

Certain interaction requirements may arise because of the context of use. For example, whereas a student in a library may have an undetermined length of time to browse, and may be working with minimal interruptions, so that the quality of feedback from the system (whether that be measured in terms of the resolution of digital images downloaded, or the number of documents on a particular topic that are retrieved) may be more important than the pace of the interaction. Conversely, a nurse on a ward who is working under time pressure will need more support to deal with interruptions (e.g. being given reminders about the current state of the interaction), or may need to be able to enter a document request quickly, possibly returning at a later time to retrieve the document that has been downloaded and printed automatically. These requirements should guide the designer of a system to configure that system appropriately – for example, allocating functions to local client or to the host server to match the users' needs.

IF aims to be neutral between users and devices, and to deal with multi-agent systems. Also, it relates domain concerns, and properties of the context of use that influence interaction patterns, to device ones. Therefore, IF has the potential to offer useful insights into the usability of digital libraries, and should provide support for designers who are aiming to design and configure more usable libraries.

## Example

To illustrate some of the issues briefly, we take one example property, and two libraries. The issue we consider is that of familiarisation, the ease with which users can familiarise themselves with the type of content and organisation of a library. First, consider a brief interaction sequence with the New Zealand Digital Library as shown in Figure 1.

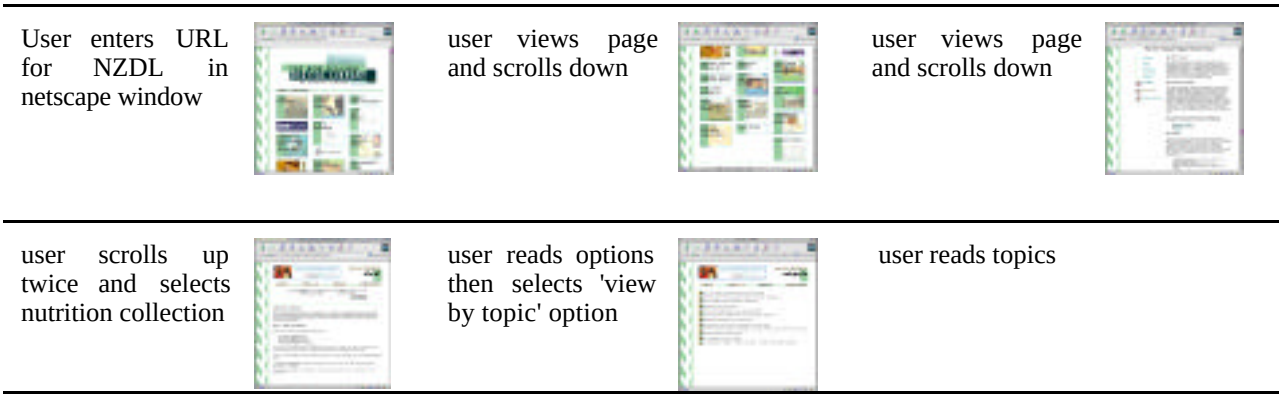


Figure 1: interaction sequence with NZDL

In this case, immediately upon entry to the library, the user is shown what collections are available: nothing about the details, but very short descriptors of each. Because the page is very long, the user will have to scroll down to see all the page. Below the collections is a short introduction to the library and to the library access software (called Greenstone). When the user selects a collection, an introductory page about that collection is shown, together with a set of search options. In the example used here, the collection accessed in the nutrition collection. This page includes, immediately visible, a paragraph 'About this collection' and one on 'How to find information'. Some of the options – for example, keyword search – may give the user little further information that supports familiarisation. Others – notably view by topic – give substantial further information on what is in this collection and how it is structured. While just viewing one collection in this way does not give a detailed view of the character of the entire library, it provides a flavour. Since a uniform structure – if not a uniform content type – is imposed on all the collections, this supports familiarisation well.

The second example we consider is the prototype National Electronic Library for Health. The interaction shown in Figure 2 starts with the user entering the 'obvious' URL for the library. Although the page announces itself as a prototype library, the opening paragraphs that the user reads give a different impression:

> "Welcome to the NeLH
>
> This document gives the background to, and motivation for, many of the aspects of the NeLH architecture which must be addressed.

The Information for Health strategy announced the creation of a National electronic Library for Health. The aims of the NeLH are to:

provide easy access to best current knowledge and
improve health and healthcare, clinical practice and patient choice.

The NeLH is organised on three floors:

Know-how,
Knowledge,
Knowledge management skills and resources.

There used to be a fourth floor - the Patient floor. Its information will now be provided by NHS Direct Online."

Thus familiarisation are not well supported by the ambiguity in role of the introductory page. If the user interprets the links to the 'three floors' as links to those floors of the library, she may follow one. In the example shown in Figure 2, she follows the link to 'Knowledge management skills and resources'. The opening text on the page reached is "The Frick Collection of art is an astonishing and beautiful collection housed in an oasis of calm on the corner of East 70th Street and Fifth Avenue amid Manhattan's hectic roar." The link to the Frick collection does indeed take one to some very beautiful art work. This is clearly (in Interaction Framework terms) a blind alley interaction: it is not leading to a library of information about health management.

If the user returns to the first page and scrolls down, there are a selection of links that appear to lead to different libraries, though with little indication of how the user might choose between them. In the case shown here, the user selects the Cochrane Library option; to go any further requires a user name and password.

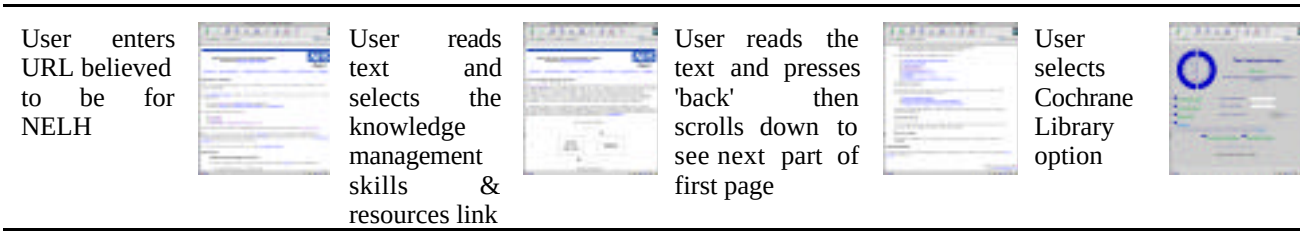


Figure 2: interaction sequence with NeLH

Only a brief interaction has been shown here, but there is a clear contrast in the ease with which a novice user can become familiar with the contents of this library. One of the challenges for us is to express these differences in a rigorous way so that those expressions can be used both to reason about a variety of existing libraries and to express requirements to inform the design or development of new libraries.

## Discussion

This work aims to advance theory of interactions, apply that theory in design and ensure that the theory has real-world validity. Therefore the methodology involves the application of a variety of techniques, some model-based and some empirical. To deliver a theoretical technique that can be used to support design and redesign, the focus will be on applying and testing Interaction Framework. Since it is neither practical nor desirable to test prototype re-designs in a natural setting, the use of Interaction Framework to guide design and evaluation will be a self-contained activity, using a local copy of the New Zealand Digital Library as the starting point for this work.

However, since the use of the artefact depends not only on the closed world of the user and device, but on other factors that are less well understood, there is a need for empirical data to inform and extend the modelling. For this, we plan to use two longitudinal case studies that deal with different application contexts: education and medical practice. Both case studies permit direct comparison between traditional and digital approaches to information provision.

This project is, as yet, at an early stage of development. We anticipate significant challenges in this work, particularly in relating local user-device interactions to the broader context of use, and in defining interactional requirements in a way that can inform design. However, while these challenges are likely to be substantial, they are a necessary step on the way towards developing applicable theory of interactions.


## *Acknowledgements*

This work is supported by EPSRC Grant GR/M81748.


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