Tailoring Claims Analysis to the design and deployment of digital libraries: a case study

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ABSTRACT

In a sophisticated system such as a digital library, design decisions made early in the design process, or at different levels – from software architecture to information content – have consequences for the design of the user interface. There is a need for tools that help developers evaluate the usability of digital library interfaces as early as possible in the design process. The work reported here has aimed to achieve two main objectives: to develop an evaluation techniques that gives useful leverage on deep design issues for digital libraries, and to overcome the gulf between usability researchers and library practitioners, such that the technique developed is usable by practitioners. Claims analysis was identified as a suitable starting point for the work. This is a usability evaluation method that specifically examines the effect of the design on the user of the interface. Four linked case studies, each further developing the approach, have been conducted. These have involved developers of two large digital library projects. The resulting technique gives support to the activity of generating scenarios which describe the context of use and encapsulate models of human computer interaction and the information seeking process. The analysis of the design rationale makes use of these scenarios to walkthrough the user activity, to consider the effect on the users' goals and understanding.

Keywords

Claims analysis, usability evaluation, design process, digital libraries

INTRODUCTION

Digital library design is a complex task for the developers, particularly because there are typically many different design specialists – from the developers of network protocols to librarians – involved at different stages of that process. Bates' Cascade model [2] offers a unified model of the many layers of digital library design and use that interact with each other, including 'the underlying network, hardware, information, database structures, search capabilities, interface design and social context' [2]. The design of each of these layers can, individually or in combination, affect the user's experience of the search activity and their success at retrieving information. Users find digital libraries hard to use, both because the interfaces are difficult to use and because the task of information seeking is difficult [4, 6,15]. Bates suggests that 'The interface design should meet not only general criteria of good interface design, but should also draw on the expertise in information system design' [2].

The work reported here aims to draw on this expertise to address the deeper usability design issues for digital libraries. By this, we mean issues that affect the qualities of the interaction between user and system, rather than simple surface-level issues to do with the way information is laid out on the screen. As discussed above, use of digital libraries is demanding in many different ways, and we are not aiming to address all aspects of user experience; for instance, the details of how users formulate queries is generally outside the scope of the approach being developed here. Rather, we are drawing on established Human–Computer Interaction (HCI) expertise, in particular established evaluation techniques, and adapting them to give leverage on the design of interaction between users and digital library features.

Within the user interface design process, Gould [12,13] found that an iterative design-test-redesign cycle is essential to effective usability engineering. Usability evaluation methods have an important part to play by analyzing the intrinsic features and principles of usability. The shared goal of usability

evaluation methods is 'to produce descriptions of usability problems observed or detected in the interaction design for analysis and redesign' [14]. Usability inspection methods [20] can be used to predict usability problems during the development process, often early on while it is relatively easy to make changes. Claims analysis [7,10,23] is one such method; it examines the design rationale and the consequences of design decisions within the context of use.

Claims analysis was selected as the focus for this research after preliminary investigation of several candidate techniques. As discussed above, we were seeking an approach that would give leverage on deep design problems. Also, it was important that developers should be able to understand and work with the technique without extensive training (so it should be fairly intuitive for developers to work with). Heuristic evaluation [24] was investigated, and found to yield useful insights on superficial aspects of design, but because a heuristic evaluation does not deal directly with contextual factors, it did not support the analyst investigating deeper difficulties; also, it provided relatively little support for analysis, so that analysts had to rely substantially on HCI craft skill in interpreting the heuristic questions. Cognitive walkthrough [29] was also investigated, but found to be difficult to apply well because it pre-supposes a well defined user goal (e.g. "I want to retrieve paper X" rather than the equally valid but less clearly defined "I want to find information about topic Y", or the even less clearly defined goals of some library users [3]), and a clearly defined sequence of actions to achieve the goal – assumptions that do not hold in many digital library interactions [2,3,15]. Claims analysis was selected for further development because initial trials yielded promising results: it is sufficiently general to address a range of design problems but – with supporting techniques as described below – it could be made to provide sufficient support for analysts to gain insights into design issues.

This paper reports on how we have tailored claims analysis to address our goals. A series of case studies, involving the developers of two digital libraries, were conducted. Each case study was devised to investigate the strengths and limitations of the approach and its acceptability to the developers, and to identify ways in which it might be adapted to better fit the needs of digital library development. The studies naturalistically and opportunistically made use of the development of new features to investigate the developers' requirements and design needs.

Claims analysis

Claims analysis is an analytical method 'for generating and evaluating potential causal relationships between features of a design and consequences of use' [7]. A claim which may be embodied in the design is a hypothesis "about the effect of the features on the user activities" [23]. A claim is not simply a statement of the designer's intention: Carroll [7] describes how claims analysis can specifically question how the design suggests a course of action, supports the user's efforts and indicates progress – or error. In this way, Carroll suggests that claims analysis enhances reflective design [8] and guides the developer to consider both the positive and negative consequences of the design on the user. The developer can reason about an explicitly described trade-off between the beneficial outcomes and adverse risks, and consider what action is needed to improve the design [10].

The story of the interaction between the user and system is captured in a scenario. Scenarios have a vital role in describing how and why the user interacts with the system [10], and have been used successfully by others in the design of digital libraries [5] and other applications [26]. According to Carroll, the scenario serves to "focus designers on the needs and concerns of people in the real world" [7] and provides a flexible representation of the system [8]. Importantly, in the case of digital libraries, this offers the opportunity to include scenarios that capture the expertise in information seeking processes [1, 3, 4, 5, 11, 15, 17, 19, 22, 30]. Furthermore, these scenarios can be developed at different levels of granularity, potentially offering an opportunity to review both functionality, and details of interface design.

Carroll [7] suggests that claims may be generated and analyzed by the developers or analysts simply scanning or questioning a scenario for obvious effects on the user in order to identify issues and possible problems. However, he further suggests that claims are stronger when grounded in social and behavioural science. For example, Norman's [21] action cycle can be used as a framework for questioning the user's stages of action when interacting with a system, including goals, planning, execution, interpretation and evaluation. In addition, Carroll [7] proposes the reuse of previous scenarios and analyses, the development of theory based on past claims, and the refinement of claims

from usability performance data. Furthermore, Sutcliffe and Carroll [28] suggest that the reuse of claims within specific contexts may make HCI knowledge and expertise more accessible to software developers.

Applying claims analysis to the digital library: an overview of the case studies

There is thus some indication that claims analysis can bring together information seeking expertise and HCI expertise to bear on the design of the digital library interface. The design of a digital library interface is very active, with new features in development intended to improve, for example, effective retrieval, collection building and collaborative working. The case studies considered both core functionality and new feature development. New features lead to new opportunities for the user, while user experience leads to new requirements being generated. This is a situation described by Carroll's task-artefact cycle [10] in which user tasks lead to new requirements while artefact design leads to new opportunities. Scenario based design offers a flexible mechanism for describing user activity and system functionality.

Given this perspective on design evolution, this series of case studies tested the application of claims analysis within ongoing design practice. Each case study was developed in response to the issues and questions raised in previous case studies and to opportunities made available by the developers. Here, we summarise the four studies and their key findings.

The initial study investigated whether the developers were able to generate claims about the effects of recent changes to the interface on the user. This established that they were able to articulate an intention but lacked confidence and experience in determining consequence. With an informal and evolutionary design process, it was also clearly difficult to recapture the design decisions that had led to the current implementation. Clear requirements emerged from the developers: that they wanted to be able to move towards solutions, not just find more problems, and that the method would need to be easy to apply in a normal review meeting.

The second study exploited an on-going design problem with a new collaborative feature, and tested a streamlined version of claims analysis. A much reduced view of the analysis was introduced to a design review meeting reviewing the development of a specific interaction sequence. Focusing exclusively on the users' goals, action and interpretation of results suggested some weaknesses in the interaction and provoked discussion on possible modifications. The broad focus on what the user wanted to do and what they understood had happened gave developers a clearer analytic structure to work within.

The third study – a user test – focused on exploring scenarios and claims as developed in the first two studies. The novice users were quickly able initiate a query and navigate towards a document relevant to on-going projects but encountered difficulties in making use of features provided to improve their search results. This suggested a need for scenarios that could describe a wider range of search activities.

The final study worked with different developers, to test the generalisability of the findings so far. An initial walkthrough of a music collection found few problems with a simple exploratory search but raised questions of functionality in considering search scenarios based on information seeking models.

Of further interest to the developer, were decisions relating to the design of a new tool to support collection building. This enabled us to explicitly analyse the relationship between design rationale and its anticipated effect on the user. Here only a simple scenario was constructed in order to walkthrough a system in development. This valuable dialogue around the scenario, users' intentions and the design rationale identified positive consequences that gave confidence to decisions made, while negative consequences were recorded for further investigation.

Description of the digital libraries

The first three studies were conducted with a corporate digital library that was created approximately seven years ago and had been regularly updated, in terms of design as well as content. The team of three developers were all experienced librarians who had special training in development. The current version, accessed through the organizational Intranet, offered a common search interface to a number of resources including two commercial abstract and index services with a full-text download

service, and a set of 'information spaces' that enabled users to browse through documents on selected topics.

The fourth study was conducted with a research digital library. At the time of the study a new collection and a new tool to support digital library design were under development. Two experienced software developers involved in the design of the system and interface contributed to this study.

CASE STUDY 1 - EXPLORING CLAIMS ANALYSIS

The purpose of this study was to explore the decisions made by the development team in a recent redesign of the interface and particularly to find out whether they could identify any positive or negative claims affecting the usability of the redesigned features.

A new browsable feature, to view collections of information on specific topics, had been included in one of the critical scenarios used in a pre-launch user trial. The developers "wanted people to be able to see what was there" and to give "a subject focussed area". In order to improve awareness of this feature, links to named topics were included on the home page.

Method

The three developers were interviewed individually, exploring a number of themes: the developers' knowledge and understanding of the user group, their identification of the most critical scenarios, and the design of selected features. They were asked to identify any positive claims and describe the aspects of the design with which they were most pleased, and identify any negative claims that were a cause for concern. The interviews were video recorded for later analysis.

General issues

From their day to day personal contacts, all the developers could identify a range of user expertise including novices, intermittent users and power users. They indicated they were pleased with progress towards their design goal of increased awareness by novices and intermittent users, as confirmed by an increase in the number of registered users and level of activity within the library. However they variously expressed continuing concerns that "people have trouble" looking for information and had poor understanding of the search support features.

Claims analysis

The design of the information spaces and the inclusion of spaces on the opening page brought a number of positive statements. These included: allowing users to view the latest developments in their preferred domain, to search more effectively for specific information within the specified collection, and to receive notifications of relevant additions to the library. For example:

> "New users benefit from seeing what the library has to offer from the home page"
>
> "Spaces give a subject-focused area, which gives more information about what is in the library, and gives novice users a better start".
>
> "Showing a random, changing sample of topics would increase awareness of the topics available"

The developers indicated a number new features and improvements intended to increase awareness and encourage exploration. However these were all expressed as intentions that had been implemented in the design of the interface. It was much more difficult for them to generate negative claims - for example the last of these three claims about the randomised display of topics of interest conflicts with a general usability principle of consistency. They expressed a broader concern for the users' success when searching:

> "Users have difficulty searching for information, and a poor understanding of search features".

Lessons learned

The developers had considered a broad context of use of exploratory first time users, and were able to account for their design rationale and indicate positive intentions and areas of concern. However, understanding the consequences of a design decision on the user, in order to articulate positive or negative claims, was much more difficult. This suggested that the developers might benefit from having a more systematic framework to assess the consequences of the design decisions – in particular, the risks of problems and threats to usability.

The exploratory model of use proposed by the developers lacked a clear purpose or structure in relation to the user's information seeking task compared to extant models of that process. The study suggested that a broader understanding of the users' requirements in relation to information seeking was needed, drawn from observation of novice users or through information seeking models which could be used as a basis for generating more demanding scenarios.

Goal directed behaviour is an important construct within cognitive psychology and human computer interaction. In Cognitive Walkthrough [29] for example, goals convey what the user wants to achieve and system feedback enables the user to evaluate their progress against goals. An important perspective on usability problems was identified by Norman's [21] action cycle, which describes the gulfs of execution and evaluation – that is, the difficulty for users of working out what to do and the difficulty of understanding the resulting system state. Carroll and Rosson [10] propose using this framework to describe user activity and generate scenarios and claims. Therefore, one further avenue to explore in our studies was making use of Norman's action cycle to provide a stronger framework for developing scenarios and generating claims but within the limits of information seeking models which suggest that users goals may be unclear or unstable.

It was clearly difficult for the developers to reconstruct their design rationale and they were not using any formal methods to capture their design decisions. It was also apparent from the developers' comments that they wanted help finding solutions rather than more problems; however, they had an informal development-review cycle for evaluating new features within which claims analysis could possibly be incorporated.

CASE STUDY 2 – APPLYING CLAIMS ANALYSIS

The design process for the library being studied was somewhat informal and evolutionary with new features and resources being added as they became available. The difficulty of reconstructing the design rationale of the previous radical redesign suggested that it might be beneficial to consider an on-going design in which the design rationale could be elicited from the developers. The development of a new feature brought with it the opportunity to thus apply claims analysis formatively, and with the objective of supporting design decisions rather than critiquing them. Furthermore, the first case study suggested there was a need for a more structured framework for analyzing design decisions, so a framework based on stages of cognitive activity – goal formation, action specification, and interpreting feedback from the system – was introduced and evaluated.

Introduction of a new feature to the library

The purpose of the new feature was to enable users to share information about useful websites and documents, collaboratively creating a searchable database. Discussions with the developers identified a current critical design problem: a form filling dialogue where users contributed details of an interesting site and nominated an interest group to notify.

Following a briefing meeting, a user scenario and a sample set of claims were prepared. The claims were constructed using the simple construct: "desirable consequence of feature or system *but* negative consequence". As noted above, the sample claims were generated using just three of the phases of the action cycle: planning, execution and evaluation. This focussed attention on a simple scenario of goal directed use, and enabled a minimal introduction of the method to the developers during a normal project review meeting [9,16].

Method

A brief introduction to claims analysis, the sample scenario and sample set of claims were presented to the developers at a project review meeting. Approximately two hours was set aside for the meeting. The system and user actions were described using a user-system scripting approach [7] As outlined in Table 1, the user needed to enter information that would enable the system to capture a web address, and distribute it to other users and interest groups. Notes were taken of decisions reached but the meeting was not otherwise recorded.

Table 1: description of target interaction

User action	System response
Click link to Share a link	'Share a link' page displayed
Fill in web address and optional comment	Echo text entry
Select distribution	Drop down list; default is current interest group
Press 'share' button	Capture web address, create summary, keywords and distribute to interest groups
Action unknown	

Sample scenario

A simple scenario described 'Natasha', who is introduced below as a novice user of the new feature. The scenario was described using prompts to support the development of subsequent scenarios:

> *Who*: Natasha, is a recent graduate and new team member.
>
> *Task*: Natasha is exploring the resources of the library as she begins a literature search in support of a new project.
>
> *Activity*: Natasha completes a form filling dialogue with the web address and some comments, and selects the distribution list.
>
> *Outcome*: On completion, the details are immediately distributed to colleagues and profiled users by email.

Sample claims

The developers were introduced to the sample set of claims structured around the action cycle of using the term 'planning' to describe activities of deciding what to do, 'execution to describe the action and 'evaluation' to describe the user's understanding of the feedback.:

> *Planning*: The form filling dialogue invites the user to share relevant information by pasting the web address into the box ***but*** the user exploring the feature cannot proceed with this activity unless they have a web address and details available
>
> *Execution*: The web address dialogue box is labelled to show the user what information to enter ***but*** the link will fail if the address is inaccurately
>
> *Evaluation*: Automatic completion saves time and effort ***but*** with no opportunity to review the results the user may not understand or may lack confidence in the action

General issues

The developers had initially expressed some general concerns for the design of a specific page, and about how the user would know about the feature. The scenario describing the interaction was extended to set the activity in its context and in order to walkthrough a sequence of events leading and following the dialogue of interest. This appeared to help to open a discussion on how the design affected what the user wanted to do and how the user would evaluate the results of their action.

The developers used the scenario and description to discuss the sample claims. They considered a number of changes to the wording and layout of the page to make it clearer and resolve ambiguities. The planning claim addressed the problem of user awareness and suggested that it would be important that the page was explicit and memorable – so that, having viewed the page on an exploratory visit, the user would remember it when viewing a page they would like to share. In considering evaluation, it was noted that there was no explicit feedback, and no opportunity for users to guess what would happen next, as the subsequent actions were automatic.

The developers reconsidered the need for feedback, the disadvantages of an additional step, and the effect of any changes on other parts of the design. After some discussion around the whiteboard, the developers suggested a practical solution to overlay an improved page to collect the required information and which would lead the user to a preview page. This avoided the need to ask the technical developers to make an operational change to the system.

Lessons learned

By setting the page in its context of use the developers were able to consider the sequence of events from a specific users perspective. By providing a simple and more systematic framework for applying claims analysis, the developers were able to consider the effect of the proposed design on the users actions and possible difficulties for the user. This successful unpacking of a design problem suggests that claims analysis would be a useful technique for the developers.

However the discussions identified some of the real world constraints faced by the developers:

- that preparing scenarios and generating claims without the support of a specialist would be a challenge
- that the time available for design reviews was very limited
- that the responsibility for some aspects of the user interface was divided between the technical developers of the system and the librarians who had responsibility for implementation

CASE STUDY 3 - TESTING CLAIMS THROUGH A USER TRIAL

The first case study queried whether the scenario and claims could be validated by empirical studies and subsequently reused in later designs. The purpose of this study was to investigate the effect of the redesigned digital library interface on novice users exploring the library.

Method

Five students on engineering placements were asked to use the digital library to find information relevant to their current projects. During the trial, which lasted about 30 minutes, each user was encouraged to think aloud as they used the library, and prompted for further explanation. Towards the end of the trial period they were encouraged to view one of the search refinement features. The interaction was video-recorded and analyzed for themes and patterns.

General Issues

Even in the brief time allowed, these first time users were able to submit simple queries using keywords and phrases and to navigate towards relevant downloadable full text or book summaries. Four of the users spent at least some of the search time looking at one of the abstract and index services; the fifth wanted a book and made it clear he did not want journal articles.

Two of the users made simple typographic or syntax errors leading to 'no matches' but these were easily corrected from the on-screen prompt. One user with a low results set and made use of the 'find similar' feature to identify documents having the same set of descriptors. He subsequently made changes to the query string, to be more generic. Another user tried entering a long phrase that the search engine was unable to match and then caused the user confusion by returning a results based on the individual terms within the phrase.

Two of the users experienced very large results sets, of 20,000 and 400,000 respectively which they wanted to and attempted to improve on by refining the query. The strategy of adding terms was inappropriate to this search engine which by default is an 'OR' search and would therefore cause more results to be returned albeit with those containing most of the terms more highly ranked.

Only one user found the search refinement feature called the 'keyword browser' while searching, and only looked at it briefly before closing it. This user, who was more exploratory in his strategies than the others, also looked at the browsable subject collections but was unable to identify one that matched his need. Towards the end of the trial, he and three others who had used the abstract service were directed to link to the keyword browser and asked to identify any descriptor terms that matched what they were looking for. They all picked out some descriptor terms, and commented that the subsequent results appeared more relevant.

Claims analysis

Within the simple scenario of first time use the users were able to successfully submit queries and find some information. However there is support for the concern raised earlier by the developers, that "users have difficulty searching for information and a poor understanding of search support features".

The users' activities were much more demanding than that described by a simple exploratory scenario, in that having found some results some of the users attempted to improve the relevance and had particular difficulty in managing excessively large results.

These users showed they had a clear goal for journal articles or in one case a book, and a requirement to refine the search. However they lacked appropriate strategies to use the search refinement features available. When directed to the keyword browser, they were able to select some descriptors; however, for both of this and the find similar feature, effective use would depend on an understanding of the use of descriptors and indexing.

This user trial suggests that the developers can claim success in facilitating exploratory use, and first time use of the digital library. However their concern about the quality of the search and difficulties in using support features is justified. Their hopes for the topic based categories was not supported in this trial since all the users immediately made use of the prominent search box to begin a keyword search. The one user who adopted a more exploratory strategy than the others did look for a topic could not find one that seemed relevant. There is insufficient evidence to determine whether this lack of affect was attributable to the design of the trial or symptomatic of a misunderstanding of the novice users needs and goals.

Lessons learned

The novice users experiences suggested that the scenarios used to evaluate the interface design needed to be more demanding to replicate the problems found. A subsequent expert walkthrough made use of scenarios drawn from information seeking process models and observations of more iterative search strategies used by experts.

The lack of appropriate strategies on the part of the novice users found here and in other studies [4] suggests a need for more explicit guidance in the interface design and for the development of further functionality for example to support simple browsing strategies described in some models [1,11,22]

Case study 4 – MODIFYING CLAIMS

The final study offered the opportunity to further investigate the application and usability of claims analysis with two experienced software developers. These developers have responsibility for research and technical development of a number of Greenstone digital library projects [31]. As found in case study 2 those responsible for the technical and system issues of digital library design may be different to those responsible for the information collection and content issues. Each, however may make design decisions that affect the user interface and users' interaction experience. Initial interviews established the context of the design activity and requirements in relation to usability evaluation, subsequent investigation of two interfaces helped to further modify the proposed analysis tool.

Method

Initial interviews with each developer, considered the context of the design activity and requirements in relation to current projects. Drawing on the findings of the novice user trial and a number of information seeking models, a description of user classifications and activities was developed to suggest possible scenarios of use. It was initially proposed to use these to analyze a design problem specified by one of the developers. After the initial discussions, further modifications were made to the proposed evaluation framework to explicitly analyze the relationship with the design rationale. Two interfaces were reviewed one including some new developments for a music collection and the other a tool to support the building of digital library collections. The analysis was video recorded.

Description of the modified claims analysis tool

The analysis tool described a preparatory phase in which to develop personas, scenarios and activities, and an evaluation phase to examine the consequences of design decisions.

In order to support discussion and development of a range of scenarios, information seeking models and cognitive models of interaction were briefly outlined including consideration of:

- the phase of interaction – for example, goal orientation, actions and interpretation;
- the stage or stages of the information seeking process – for example, query formulation, evaluation of results of a search or extracting information;

- the information seeking task – particularly imprecise searches and 'orienteering' and 'berry-picking' strategies.

The scenario and a list of the interaction sequence formed the core material from which to discuss the design rationale and the effect of the design on the user.

Issues

Music library interface

User goal	*User action*	*System prompt or response*	*Design rationale*
To listen to music collection	Select music collection icon	Open music digital library collection home page A-Z title button	User can explore by following links to title list
To select song	Select A-Z title list	Open list of song titles	User can explore and scroll through list in alphabetic order

Fig 1 Sample of user interaction to browse a music collection

Briefly, the developer chose to describe first a simple scenario of a new user exploring the collection for the first time in a browse style search task. (See sample Fig 1). Walking through this simple task showed that the user could find and play some stored tunes by simply following the links on display. However the process of considering the scenario raised some questions about the user's intentions and actions – how would they know what to choose, would the user just follow links or have a title in mind, and what would they want to do with the retrieved music file? At a more detailed design level, observing that a button marked 'Browse' led to a search box raised a further question of users' expectations and strategies in relation to searching a specified query and browsing by navigating categories, links and lists. These questions suggested an opportunity for further development of the design requirements and functionality for example to support a more sophisticated browsing-searching activity as described in various information seeking models.

Positive claims could be made about the use of icons and labels and lists to suggest to the user what to do and how easy it was to find and play some music. Browsing through the title list supports exploratory and opportunistic discovery of familiar or interesting titles.

Negative claims could be made within the context of different search goals where the user might for example want to link to and compare different variations of one tune or song. There was no suggestion of further goals or activities to encourage the user to expand the search or follow-up related items within the collection.

Collection building interface (the 'Gatherer')

A second problem identified by the developer was in the design of the Gatherer tool. This is a graphical user interface being designed to help librarians gather documents and build a collection through the Greenstone digital library. Significant decisions had already been made earlier in the design process – for instance to use a tab-based form filling dialogue with information flowing from one panel to the next. The design intention and requirements were to simplify collection building to the point where it could be undertaken by a librarian or other holder of documentary material, who would continue to have an interest in maintaining the collection. The tool would enable the librarian to add metadata locally and make small modifications to the interface.

Using only a simple outline scenario of the user context and action sequence, it was decided to walk through the sequence using a prototype version, building up the scenario, action and design rationale. The outline scenario proposed by the developer was: to consider a first time user building a sample collection, in order to familiarize themselves prior to building the intended collection. The developer expressed a preference for considering a new user, using the application for the first time which he hoped was representative:

> "I am trying to think of someone, I think of someone who hasn't seen this screen before – I am thinking maybe of an initial user who has run this for the first time"

"I am also kind of assuming that a person using this program for the first time would presumably think 'let's try and do a simple example". And that in itself could turn out to be a rather, not a true assumption"

"They may have moved into a more inquisitive cycle where they click on those menu items at the top, maybe look at these names here to see if that makes sense"

There was also some discussion concerning the users activities and possible goals or goal hierarchy, and sub-goals. The developer decided that the initial activity contained an overall goal to build a test collection, and contained sub-goals to initialize the digital library and collect files:

"The goal of the tool is to help people do this, collecting files and building of collections. That's very very broad"

The broad grouping of these activities matched the functional groupings already used in the interface design. The design rationale at the opening screen was that it was intended to convey to the user that nothing could be done until they went through a procedure to initialize the new collection - all other options were greyed out:

" so I have run the program and have a window that comes up. A number of options here are not available because there is no collection"

"…trying to give the idea that if you haven't got a collection there isn't much you can do."

Thus the rationale and effect of this decision was to limit the available options and to encourage the user to open the file menu and select NEW. As a potential negative effect this is implicit rather than explicit and contrary to experience with word processing applications that open straight into a blank document. A novice user could be left wondering what to do to get started.

Once a new collection was initialized the tabs are available and the user works through each activity as required on each panel:

"We believe these panels are straightforward for the users to learn."

"not trying to develop radical new tool…….(we are) ….trying to make things look familiar"

"so the next big step for the novice user is by looking at this if they can sort of work out the next thing to do, to go on to the next panel."

However the designer was not necessarily confident in decision made and wondered:

"whether or not the user will come to terms with going to these different panels."

The positive effect here is a visual grouping and sequencing of related activities suggesting specific goals or sub-goals. Some of the activities such as collecting the documents or adding the metadata could be repeated many times before moving on to the next stage. Possible negative effects were identified where subsequent editing activities would not have the same sequencing effect.

Describing current evaluative practise it appeared that design process was informal with regular review meetings to examine progress made by the programmer who was writing code. The programmer necessarily made many detailed level decisions about what went where and how objects behaved prior to the review. Because of uncertainty about what would work at the technical level, the developer explained that sometimes

" you can't do a worked scenario, at least until you have got something that is plausible"

Discussing the evaluation within the design process, the developer commented that they usually looked for bugs that might cause system failures:

"we almost adopt this pathological user type testing where we just try to think of as many kind of not non-intuitive things, but as many things as possible that might break it."

Developing the scenario proved useful:

"….but it has all been triggered by doing the scenario - thinking out loud – to me this is good – …because…you just go through the scenario, you encounter something and think hmmph - not sure about that, and then with this sort of thing here the idea would be to try and classify at what level are we needing a solution."

It was important to the designer that problems could be classified according to its effect on the design:

"So the question is, what are the reasons, is it just due to a bug in the program, or is it due a presentational issue."

It was important to find and resolve these problems in order to release a reliable system. Identifying bugs – similar to the pathological user testing, revealed where the system would be unable to handle the request and thus crash. Presentational issues were where the user did not know what to do and could be resolved with an improved prompt or more explicit feedback. Those that were attributable to the design issues and functionality were potentially more serious, suggesting a significant need for redesign.

The designer was reassured that the evaluation was primarily identifying bugs and presentational issues that could be resolved by minor changes to the design,

> "6 month earlier with this project and you would be finding a lot more bugs and you would be thinking about the design process maybe"

During their normal evaluative process the designer was familiar with using scenarios to describe system use and to recording problems found for subsequent investigation. He could envisage the investigation as being a dialogue between a developer and evaluator.

Lessons learned

The walkthrough of the music collection went some way to validate the use of a richer selection of user activities derived from information seeking process models. It is important that the developer considers a variety of possible scenarios of use and user needs that provide the context for the interaction. These encourage the developer to question how the design supports a broader range of strategies.

Importantly, the level of problem identified needed to be appropriate to the stage of development – the developer was at a stage of considering presentation issues such as content and naming of prompts, and checking for bugs. Contrary to earlier assumptions the designer preferred to find and resolve presentational issues at the current stage of the design activity. Finding an opportunity for creating new features, while interesting for the future, was not the immediate priority at this point in the design cycle. Some level of confidence was gained, in that walking through a simple exploratory search suggested that the users could reasonable be expected to form appropriate goals and make sense of the results. This need for confidence was clearly important in the uncertainties of design decision making, and draws attention to Carroll's direction to identify both positive and negative consequences.

This was strongly apparent with the Gatherer tool, for which there had been no evaluative review outside of the design team. The scenarios for this new application could only be derived generically from experience gained from use of the earlier version that had led to a decision to build a much simpler, graphical interface. Further research with potential user groups or of models of indexing and metadata use could be applied to build richer scenarios in the same way as using the information seeking models to analyze core activities. The discussions around the probable user activity helped to elicit the implicit assumptions and design rationale. Further discussion indicated alternative solutions to design issues, as well as issues to be taken away for further consideration.

The process of considering the consequences for the user brought about an improved understanding of the design requirements and possible sources of confusion. The discussion was dynamic and interactive, commensurate with the normal informal design review process practiced by this group. The simple framework addressing what the user would want to do and how they might interpret the results helped to question and validate design decisions.

DISCUSSION

Taken together, this series of case studies has investigated the application of claims analysis to the design of digital libraries, exposing some practical problems with applying the method and revealing some interesting design challenges for the developers taking part. Simple outline scenarios were enriched by considering the users prior experience and context of use drawing on local observation of user behaviour and significantly enhanced through the application of information seeking models. Specific scenarios were found useful to contextualise particular design issues of concern to the developer and to describe sequences of actions on the part of the user. The analysis of the effect of design decisions on the user was primarily framed around how the user knows (or decides) what to do and how they understand or interpret the response from the system. Positive effects discovered in

this way gave the developer encouragement that the design is progressing successfully, while negative effects were further discussed to consider alternatives or the need for change.

The developers context in both the case study digital libraries is of an evolutionary design process, with the basic structure of the digital library complete. Both practice informal design methods, exploring, building, testing and refining the interface. They had no formal methods of recording design rationale apart from what had been implemented. The first study showed that the developers had focussed on design solutions that could resolve a problem regarding awareness of the resource. They expressed some concerns at the detailed level but it was difficult for them to articulate consequences of their design decisions, especially any negative consequences. Their intention and hope was that the changes made would be helpful to the users.

In the absence of experience and knowledge of HCI principles of usability, it was difficult for the developers to be analytical about the consequences of their design decisions for the users. Provided with a very limited part of Norman's action cycle as a framework for examining goals, actions and interpretation, they were able to step outside the immediate page-level design problem to consider the context of the interaction. This enabled them to reason about the deeper implications for usability and alternative design opportunities.

The later novice user study indicated partial support for a simple exploratory scenario as described by the developers. However, this study also suggested the need for more critical scenarios to evaluate the search support features and browsing strategies as described in information seeking models. A broad and comprehensive view of the user information seeking activity was important to developing scenarios that challenged the interface design as found in the review of the music library. These suggest improvements that could be made to the functionality or a need for further guidance to help users to make better use of the functionality provided. However – a note of caution hangs over the assumption of identifying deeper issues late in the design process. The developer in the final case study was at a stage where he wanted input on presentational issues and was not able to react to deeper level issues.

One of the most pressing needs for the developers involved in this study was in supporting the active design of new features. In wanting to design interfaces for new and innovative features, the developers actively needed guidance on the effects of their design decisions on the users.

In the final study, the claims analysis technique was adapted to offer a simple framework for describing users activities, framing them in a way that supported reasoning about the user-system dialogue. Capturing both positive and negative consequences for the user, grounded in human computer interaction theory as well as the context of use, gave confidence about the design decisions made and served as a record of the design rationale.

These real life case studies make only passing reference to huge bodies of research in design process and rationale, use case scenarios, human computer interaction and information retrieval in order to frame a very simple, low cost evaluation early in the design process.

To those researching design rationale the process of capturing design decisions, for example through QOC [18, 25] is a well-documented activity even if designers are often reluctant to maintain the necessary documentation. The need to compare the design rationale to the user's goals creates a real-time benefit that offers to support decisions and raise confidence as well as examine problems.

To those researching human computer interaction another issue became apparent concerning the use of scenarios and the identification of goals. The need to generate representative scenarios and action sequences, calls for further ethnographic studies of users of specific applications. Reviewing the dialogue between user and system is suggestive of Suchman's [27] model of plans and situated actions. This model challenges the concept of goal directed behaviour, and matches more closely the developers' preferred descriptions of first time exploratory use in which the user is largely reactive, and to information seeking models where the user has no clearly articulated goal. The user is instead relying on context, prior experience and the artefact - prompts and feedback – to reason about what to do. This first time exploratory use scenario is both more demanding of the system designer to provide good prompts and feedback, and less demanding since there is little requirement to

predetermine goals other than of serendipitous investigation and mean-ends reasoning. Thus, it provides an alternative perspective which is worthy of further investigation.

Claims analysis is not a simple evaluative tool [9,16] but does call on activities with which developers are familiar, for example use-case scenarios and design rationale. The *process* of building scenarios and claims created an opportunity for dialogue and provided a place to integrate expertise from information retrieval and human computer interaction. Further investigation needs to determine how useful and usable this process is, at what phases of the design process the results have most impact and what types of design decision are best supported. The work reported here lays the foundations for such studies, having identified some key factors for success, and contributions of using claims analysis in design.

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