Enhancing User Interaction with Electronic Journals via Interactivity and Value-adding Features

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Abstract
PROPIE is the proposed information environment designed for enhanced interaction and value-adding of electronic documents such as electronic journals. The design of PROPIE was based on a thorough review of user needs and requirements in interacting with electronic information, a focus group with twelve participants to identify desirable features in future interactions, a review of developments in various user interface (UI) technologies, as well as a consideration of novel information structuring and organising techniques that pose important implications for the design of more advanced UIs. An empirical evaluation involving eighty-three participants from a variety of academic background was conducted to obtain representative users’ feedback. Generally, the findings show that for e-journals to survive and thrive, they must be different from their print antecedents, with advanced interactivity and value-adding as distinct characteristics.

1.0 Introduction
Once a matter of great debate (Coward, 1993), scholarly e-journals have proliferated rapidly as evidenced by a number of developments such as:
- the emergence of a large number of e-journal titles to warrant a collection of collections of relevant links to them (Jones, 1999)
- the introduction of an e-journal devoted to electronic publishing (Journal of Electronic Publishing)
- a large body of literature published with reference to e-journals (Bailey, 2000)
- conferences being held in which e-journals present as a major topic of discussion (e.g. ICCC/IFIP – Electronic Publishing’97, 14-16 April 1997), and
- public funds spent on supporting them (JISC, 1999) and archiving them (PANDORA Project, 1997)

While some (Harnad, 1997; Rowland, 1997; Sosteric, 1996) still question whether the paradigm shift to e-publishing will affect the complete scientific communication process immediately and to what extent, a fact is that interests and enthusiasms in e-journals have grown tremendously over the recent years. Results from a recent study carried out to look into end-users’ use and perception of currently-available journals and their expectations for future e-journals confirmed this claim (Liew, Foo & Chennupati, 2000a). Generally, e-journals are expected to be different from their print antecedents, primarily in providing users with novel forms of interactive features and value-adding information not possible in print.
2.0 Study Objectives

This study aims to examine the broad issue of supporting the wide range of information searching, analysis and communicating tasks involved in interacting with e-documents within a single UI environment, using e-journals as an example of e-documents. Two phases of empirical evaluation were conducted at the Division of Information Studies (DIS) Laboratory, Nanyang Technological University (NTU). Results from the first phase of the evaluation have been reported in an earlier work (Liew, Foo & Chennupati, 2000b). The second phase was aimed at collecting additional data to validate earlier findings and to address new issues surfaced from the first set of data. This paper reports the first combined results from both phases of the empirical study.

Due to space constraints in this paper, fuller details of various aspects of this study are provided in the form of references to previous works published. Earlier works leading to the design of PROPIE have been reported in Liew & Foo (1999). A detailed description of PROPIE and the various features and tools incorporated within the environment together with a set of mini scenarios and some representative displays have also been reported (Liew, Foo & Chennupati, 2000c).

3.0 The Proposed Information Environment (PROPIE)

PROPIE is an integrated and unifying environment comprising of four independent yet co-ordinated workspaces. Users have the autonomy and flexibility to use either all the workspaces in a unified manner, or to use each of them independently according to different needs. Information objects within the environment are fractionally structured and can be laid out on the surface to depict this fractal structure. All objects (each associated with a rich prescription of metadata) at any granularity are queriable and navigable. The ‘body-and-clone’ analogy is applied in PROPIE so that the original body of the document is kept intact in one of the workspaces, while allowing information objects within the body (i.e. clones) to be moved to other workspaces for further operations to be carried out on these objects. Figure 1 shows the main interface and the four basic parts of PROPIE.

The four workspaces of PROPIE are:

1. The InfoSphere Organiser - the part of a wider information work sphere whereby users organise and display their information collections (including their personal collections, and information residing outside the user’s current workspace). Various interaction and visualisation techniques can be applied to obtain a view into this sphere and the various items in the collections. To further explore an object, users can drag the object and drop it into other workspaces. This broader workspace is closely integrated with the following user’s personal workspaces.

2. The Object Viewer - the workspace whereby users get a first glance of the content of the selected object. It is closely integrated and co-ordinated with the Structure Viewer/Overviewer to provide user with a co-ordinated display and directed-navigation to browse through documents.

3. The Structure Viewer/Overviewer - provides an overview display of the object structure to maintain the overall context of the selected document. Users are given a set of display options to examine the structure and layout of the object.

4. The Object Explorer - the ‘value-adding’ aspect...
of the environment that allows users to perform a variety of other tasks to further analyse various information objects. Various tools are available - such as a ‘History Cabinet’ that serves as a ‘store’ for users to maintain a record of history for backtracking, and a ‘Pocket Register’ – serving as an interactive, multi-object ‘back pocket’ whereby information objects collected at any of the workspaces can be deposited temporarily, staying ready-at-hand for further exploration while users explore some other objects in the workspaces.

4.0 The Empirical Evaluation
The first empirical evaluation involving 22 participants was conducted in September/October 1999 and the second session, with a larger pool of 61 participants, was conducted in March/April 2000.

4.1 Methodology
A formative evaluation (Patterson & Bloch, 1987) approach is chosen as too little is currently made known about the application of various novel interactive and visualisation techniques within one single UI environment to enhance interaction with e-journals (or e-documents) to formulate specific hypothesis. A scenario-based approach is used to demonstrate how such an environment is likely to be used for interacting with e-journals. The scenarios and tasks chosen provide reasonable coverage of the typical and desired information-seeking tasks involved in interaction with journals. They also reflect the kinds of tasks PROPIE would address if implemented as an operational system. Together with the mock-ups of the desired output, they serve as the platform for the empirical evaluation. Materials used in the evaluation included a consent form, task instructions for each of the scenarios and a series of questionnaires. Full versions of these resources can be found at http://islab.sas.ntu.edu.sg:8000/islab/research/cher

4.1 Study Participants
A ‘purposeful sampling’ approach (Patton, 1990, p.169) was taken. Participants were recruited on the basis of their availability, and for their experience in computers and journal usage. The profile of participants is outlined in Table 1. There were slightly more females (54.2%) and the majority of the participants were in the age groups of ‘18-29’ (48.2%) and ‘30-39’ (37.3%). All participants had different levels of experience with both print journals and online journals but were all representative users of future e-journals.

<table>
<thead>
<tr>
<th>Table 1 Participants Profile</th>
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<tbody>
<tr>
<td>Part-time Masters students enrolled in 1999/2000- H6324 Systems Analysis &amp; Interface Design course, DIS, NTU.</td>
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<tr>
<td>Part-time Masters students enrolled in 2000/2001- H6304 Design &amp; Delivery of Information Products &amp; Services course, DIS, NTU.</td>
</tr>
<tr>
<td>Full-time research students in Information Studies, DIS, NTU. [Ph.D. (1), M.A.Sc. (2)]</td>
</tr>
<tr>
<td>Voluntary participants invited from NUS – part-time graduate students majoring in Engineering. [Ph.D. (1), MEng. (12)]</td>
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<td>Total number of participants</td>
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5.0 Research Findings & Interpretations
5.1 Findings from PROPIE Evaluation
This section reports a segment of the findings that present significant implications for the design of future e-journals. For interested readers, a detailed reporting of the results based on thorough statistical analysis and content analysis (of qualitative comments) can be found in Liew (2000).

5.1.1 Browsing through collections
Participants found it useful to be able to access one’s personal and external collections within one dedicated workspace. They also welcomed the idea of utilising two to three pop-ups simultaneously to view and compare details of selected objects. Visualisation techniques such as the ‘Timeline’ (to show distribution of related works), the ‘Forager’ and ‘Map’ (to display ‘focus+context’ view and distribution of documents within collections) and ‘DocTOC’ (to show size of documents and the types of objects
contained within documents) were received positively. Most participants however, found the ‘CamTree’ (Robertson, Mackinlay & Card, 1991) a little too difficult to use. The visualisation was found too cluttering although a few of them nevertheless, managed to note some values in using it for manipulating and exploring large collections of documents.

5.1.2 Seamless access to other information sources
Participants generally welcomed seamless access to other information sources - thesauri, an attached glossary/definition and a translation tool as value-adding features. Additional comments gathered indicated participants’ appreciation of these features beyond that of the current proposed use (in e-journals) – suggesting similar features to be incorporated in for instance, knowledge management systems and, financial and personnel systems. A few participants also suggested linking to other sources such as to an encyclopaedia, a yearbook or to a ‘Who’s Who’ directory, while a number of them pointed out the importance of ensuring the accuracy, authenticity and comprehensiveness of such value-adding information.

5.1.3 Browsing through items of interest
Object Viewer was found useful to get a quick view of a selected object. When combined with Structure Viewer/OverViewer for highlight-directed navigation, the response received was also generally positive. The ‘Thumbnail’, ‘Book’ (Card, Robertson & York, 1996) and ‘DocLens’ (Robertson & Mackinlay, 1993) displays were introduced. While participants were obviously more familiar with the ‘Thumbnail’ display, many of them also recognised the potential features of the other two displays. They specifically found the ability to digitally ‘bookmark’ sections of documents useful. Many of them welcomed the idea of presenting users with multiple choices of representations to a document.

5.1.4 Filter/Arrange
Filtering and arrangement (and rearrangement) of information were proposed in PROPIE to help users focus on important details. 61.5% of participants thought the ‘Filter’ tool was either ‘Essential’ or ‘Very Useful’, while only 16.9% of them rated the ‘Arrange’ tool as ‘Very Useful’.

5.1.5 Collaboration
Participants largely adapted well to tools that were proposed to stimulate collaboration amongst users. A number of suggestions (e.g. a point-grading system in organising the comments and annotations; grouping by topics, dates or author) to improve the display of comments and annotations were put forward. One of the most interesting observations was that there was an emphasis on adding personal annotations rather than checking others’ notes. Many additional comments received substantiated this observation. Participants were also introduced to the idea of sharing one’s search/browse history records as a means of collaboration. Some appreciation of this feature as a means of exchanging information was reflected in their ratings and comments.

5.1.6 Temporarily storing items of interest
The idea of a ‘Pocket Register’ received quite a positive response from participants, with about 60% of their ratings distributed over “Essential” and “Very Useful”. A number of participants suggested improving the ‘interaction’ aspect of this feature by for instance, removing the ‘drag & drop’ and allowing user to save by a right-click. One participant also proposed incorporating iconic design to this tool.

5.1.7 Browsing through related work
The ‘Research Compass’ with its three separate tools was introduced to participants - The ‘Citation Linking’ and the ‘Document Mapping’ was received positively; the ‘Document Similarity’ received an averaged rating. Many found the visualisation in the later too complicated for first-time users although some appreciation of its use as a ‘research compass’ was noted. Participants were most comfortable with 3-4 shapes or colours in use to visualise information, consistent with many existing findings such as those upheld by Shneiderman (1998, p. 399) - that the use of colours or shapes in a single alphanumeric display should be limited to four (at least, for novices).
Participants generally demonstrated an appreciation of the usefulness of the ‘Alerting/Updating’ tool in updating users to recent related works in various fields. Many still prefer the familiar ‘list’ view to display information in preference to other options – ‘Time Line’ or ‘Map’. However, a few of them exhibited an awareness that a ‘list’ might not be the best option at all times especially when the items/collections grew and welcomed other options.

5.1.8 Interacting with multimedia objects
Participants reacted positively to the multimedia-based features. Checking out a demo in Object Viewer while maintaining the context of the original document proved to be popular. Although most participants were unfamiliar with the ‘live test’ and ‘interactive data sets’ features, most of them received the ideas positively, foreseeing their potential as value-adding features. Many also suggested alternate means to further enhance the features in ‘Image Quick View’, such as to have more flexible zooming mechanism. 74.7% of participants welcomed the ability to arrange the images by ‘topic/subject’. Less than half though, thought that arrangement by ‘colour’ (41%) or ‘shape/geometry’ (24.1%) was useful.

5.1.9 Backtracking
The backtracking features were received positively. Suggestions to improve and enhance ‘History Cabinet’ and its ‘Archive’ included:

- To allow users to undo/remove unwanted/out-of-date history records
- To ensure easy access to the tools (e.g. iconic design, easy menu selection)
- To have more user-friendly interface and interaction for these tools

For the displays in ‘History Cabinet’, participants again showed a preference for the more familiar and ‘easier-to-use’ list view. Appreciation of other display options was reflected nevertheless, in some of their additional comments. For instance, the ‘Calendar’ view was deemed more value-adding in that it allowed some kind of categorisation of events. Participants also liked the use of ‘Timeline’ in depicting the distribution of activities. Some of them also expressed interests in the ‘Graphical History’ and indicated that such graphical representation were innovative and easy to use. Many participants however, found the visualisation used in ‘Perspective Wall’ (Mackinlay, Robertson & Card, 1991) too confusing to be useful.

5.1.10 Extracting items of interest
The ‘drag & drop’ mechanism was positively rated by majority of the participants. 94% of them thought it was the most intuitive method to move objects within the environment, followed by ‘highlight to select object, right click and then select move option from a pop-up menu’. Ten participants indicated that more than one option however, might be necessary to suit different user needs and experience.

5.1.11 ‘Focus+Context’ viewing & exploration
Participants were introduced to the ‘body & clone’ and ‘multi-clone’ analogies. Three participants had a preconception of the ‘multi-clone’ concept before they were actually introduced to it – demonstrating a learned understanding of the analogy. They were able to visualise the various use and benefits of the proposed analogies to, for instance:

- “…gather a few ‘clones’ from a few articles … Then decide what to do with them.”
- “…apply different tools to the same clone …”
- “…create a few clones of the same paper …and use them for different projects.”
- “…take a few links in the document that don’t appear on the same page and place them all in object explorer first. Then, …check out each, one by one without going from page to page to find them again.”

Many also perceived the significance of ‘focus + context’ viewing. They saw it as useful in helping users moving between different tasks without losing the context.
5.1.12 Controlling the amount of information displayed

Most participants favoured the idea to be allowed some kind of control over the proposed environment. It was also obvious that participants preferred having some kind of control of the amount of details presented to them (e.g. by layers/levels). Many went on to suggesting breaking down the ‘layers/levels’ into even smaller sections so that user could choose as precise as they could on the details they wished to check out.

6.0 Discussion

Valuable insights have been gained in the designing of a newer-generation of value-added e-journals through the empirical evaluations. We discuss the general implications in the context of what we believe would characterise future forms of information environment that support enhanced user interaction with e-documents such as e-journals.

Integration of workspace - Integration of a user’s workspace and the broader information world would be crucial in enabling a uniform paradigm for accessing one’s own workspace and the information at large. This integration would also facilitate the task of consolidating one’s intermediate and final information searching results into the initial task.

User-controlled malleability - Throughout the workspaces, users would be able to perform direct manipulation (DM) on information objects at different levels of granularity. Users could for instance, re-arrange or filter information in display, and zoom in on selected objects for more details when required and desired. They could also explore, navigate and perform queries almost simultaneously, and intuitively select, drag and drop objects throughout various workspaces.

Visual sovereignty - Users would be provided with contextualised views during their information gathering and analysis tasks. How an item fits within a collection set and within the broader information world would be indicated to users through various visualisation and interactive features. As importantly, users would also be able to backtrack their browse and search history records through visual representation of the records.

Multiple representations/views - Users would also be given a multiple representation of information objects to support a variety of their needs and preferences. PROPIE’s interface for instance, allows DM on various aspects of the representations and views and their organisation. Users could choose a view of interest from multiple displays and organisation options according to the task(s) at hand and their needs.

Integration with appropriate tools - Such environment would also provide users with an integrated suite of interactive tools for querying, navigation, organising and authoring information. Users could for instance, specify a query against a set of objects, browse and navigate with aids of visual clues about where items are, and seek specific information by a zoom mechanism. Users would also have the ability to make and save digital comments and annotations, and attach these to an object (e.g. an article, a paragraph or an image). Seamless access to other value-adding information and the ability to interact with multimedia objects would also be available to users.

Limitations of study

We acknowledge a number of limitations in the study as a result of the assumptions made in the design of PROPIE and the chosen evaluation techniques. The choice of using e-journals as a form of e-documents in this study has somewhat implied that the results gathered would not be totally generalisable to all other online documents. We have also not investigated the impact PROPIE has on different genres (e.g. subjects) of journals. The simulated mock-ups used in the evaluation are apparently inferior to that of a working prototype. Reasons of feasibility and implementation made full-prototyping impractical. We have also not conducted a thorough feasibility and cost
evaluation, or attempted to look at the legal and practical issues. These investigations and estimates would be essential to make what have been proposed in the study a realism.

7.0 Conclusion

We have taken an immense leap in this study to examine features and functionality desired in a newer-generation of enhanced e-documents such as e-journals. PROPIE has been designed to investigate how various tools and features can be integrated into one single UI environment, whereby users can apply different tools flexibly and in a complimentary manner so as to facilitate, enhance and add value to their various needs in interacting with electronic information. We believe we have made substantial progress toward that goal through the empirical evaluation conducted, gathering important feedback with regard to representative users’ perception and satisfaction with various aspects of PROPIE. The results generally indicate that there is undoubtedly, a growing interest in e-journals and users expect them to offer advanced forms of interactivity and other value-adding features that print journals cannot offer. Based on the findings, we further believe that our success with the environment can be improved with some modification to the UI, increased user training or experience with the environment.

As part of our future work, we intend to verify empirically if user individual characteristics (e.g. gender, age, spatial ability) and user experiences (e.g. computer and journal usage) have an effect on how participants perceive various aspects of PROPIE, particularly on features that are visualisation-based that call for certain degree of spatial orientation and scanning ability. The findings will further contribute to our understanding of how user interaction with e-documents can be enhanced.

References


Mackinlay, J. D., Robertson, G. G., & Card, S. K.


