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From Documents to Discourse: Shifting Conceptions of Scholarly Publishing

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From Documents to Discourse: Shifting Conceptions of Scholarly Publishing

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ABSTRACT

We are looking at how new forms of document interface can be used to support new forms of scholarly discourse, and ultimately, new models of scholarly publishing. The vehicle we use to conduct this research is the Digital Document Discourse Environment (D3E). D3E is an experimental system supporting the publication of web-based documents with integrated discourse facilities and embedded interactive components. We report here on two cases – an e-journal and a ‘new form’ of conference – where we have used D3E to promote new forms of discourse between participants. We use these cases to illustrate four principles that guide our socio-technical design actions.

Keywords: Argumentation, Digital Documents, Discourse, Electronic Publishing, Hypertext, Scholarly Publishing, Socio-technical Design, World Wide Web

INTRODUCTION

Currently, we are witnessing the beginnings of a shift from paper to digital media in the submission, review and publication of scholarly work. For many journals and conferences, it is now standard procedure for reviews and submissions to be transmitted electronically. Sometimes, automated systems are in place for matching reviewers with submissions based on keyword analysis. In a few cases, the final document version is even published electronically as a set of hypertext files available on the World Wide Web (see [12, 13] for examples). However, while various documents are becoming digital and some activities are automated, the process of scholarly publishing has remained largely unchanged. One can argue that, similar to other domains such as educational technology [24, 28], technology is most often being used to enhance traditional practices rather than to significantly rethink existing models of work.

The goal of our research is to use technology to rethink current publishing practices in order to promote new forms of discourse between participants. The vehicle we use to conduct this research is the Digital Document Discourse Environment (D3E). D3E is an experimental system supporting the publication of web-based documents with integrated discourse facilities and interactive components.

The first D3E project was to create an electronic journal on the Web (e-journal) supporting on-line peer review and embedded demonstrations. It became clear that production tools were needed to make the publishing of the journal tractable. It also became clear that there were many contexts where documents need to be discussed in different ways by different scholarly populations. This motivated the requirements for a generic publishing toolkit which could be used to generate a variety of sites. The concept of a tailorable environment was conceived, with the project's research goals being to better understand the factors that make discussions around media-rich web documents desirable and effective.

In pursuit of our research goals, we are following an iterative socio-technical design approach [21]: in addition to designing the D3E system, we also consider what processes are needed to promote and sustain changes within a specific community. To date, we have used D3E in numerous contexts, including the publication of several e-journals [5, 14], a national debate on government policy recommendations [15], and a ‘new form’ of academic conference [16]. Here, we report on two of these cases – JIME (an e-journal) and learning.org (a conference).

The remainder of this paper begins by discussing the motivations and design principles underlying D3E. We then use a scenario to illustrate how these principles are realised in the D3E toolkit and document interface. The heart of this paper examines how D3E has played a role in rethinking practices in two scholarly contexts.

MOTIVATION AND DESIGN PRINCIPLES

Brown and Duguid [2] contrast two models of document use – documents as darts and documents as a means of making and maintaining social groups. The ‘darts’ model refers to the notion of documents as a paper-based transport mechanism carrying pre-formed ideas through space and

time. In the broader social model, they trace the ways documents serve as a medium for negotiation within communities, as members struggle to reach a shared interpretation. These negotiations take on different discourse forms, including discussions, debates, annotations, and even live events, such as presentations.

Current publishing practices reinforce the idea of ‘documents are darts.’ These practices have arisen over the last few hundreds of years from the affordances of paper and the difficulties of communicating over large geographic distances. Paper-based publishing models, such as the typical journal review process, sever all links between the document and its surrounding discourse, and between the end product and the process that shapes it. This has shortcomings in that questions go unanswered; confusions go unclarified; criticisms go undefended. Reviewers (and readers) are engaged in an imaginary debate with distant authors who are not present to respond. The dynamic cut-and-thrust of debate normally found in face-to-face contexts such as conferences and workshops is not supported.

Four Design Principles

We are using technology to explore different socially-based publishing models where documents serve as ‘a medium for negotiation.’ Towards this end, we are rethinking both our processes and products to support document-centred discourse. This rethinking is guided by existing research into how hypertext systems can support critical reflection. Over a period of six years, we have surveyed, prototyped and evaluated the usability and effectiveness of various argumentation and design rationale systems [3, 4, 25]. Such systems are designed to support the representation and analysis of arguments, and to capture the decisions and reasoning behind the design artifacts being discussed. From this work on pre-Web design support systems, and from our experiences using D3E, we have formulated four principles that have guided our design activities. Some of these principles are realised through system design, while others are realised through social means:

- A: Avoid elaborate structuring schemes.
- B: Integrate documents, demos and discourse.
- C: Redesign work practices to emphasize discourse.
- D: Support the new practices with tools.

Principle A: Avoid over-elaborate schemes for structuring discussions. If users classify their contributions to an on-line discussion, greater computer support can be provided. For instance, one can search for all *Theory* comments that have *Contradictory Evidence*, if those categories have been defined. A number of expressive schemes have been proposed (e.g. [7, 27]); many schemes require users to categorise contributions as *positions*, *issues*, *comments*, *pros*, and *cons*. This, however, runs the risk of burdening people with excessive representational overhead by forcing them to categorise their ideas before they are ready to. Numerous studies show that users are often unwilling and/or unable to use elaborate schemes, because the effort is too great [3, 4, 23].

Principle B: Computational tools must tightly integrate documents with their associated discourse. Many systems place the documents under development in a different application to the discussion about them (indeed we see this with many e-journals and their discussion lists). This separation hinders users from quickly accessing relevant comments when they are most needed and makes it is hard to add new comments. Likewise, tools should tightly integrate the textual parts of documents with the computational parts. Research in design support tools has shown that users need to easily bridge the separation between different representations of the design and between representations and design rationale[9, 20, 25]. In our case, we must enable users to move seamlessly between reading the document and making a comment, and between reading and interacting with an embedded demonstration.

Principle C: Work practices must be redesigned so that structured discussions are an integral product of the overall task. Studies show that people often do not contribute to discussions because it is perceived as extra work over and above what they are already required to do [11]. Successful approaches have redesigned work practices to make contributing to a discussion integral to the overall task being performed [26]. Others also advocate seeding; i.e., providing some initial contents, arguing that people find it easier to contribute to an ongoing discussion rather than starting from scratch [10]. In a journal review setting, this means redesigning the review process to require electronic threading of reviews into a shared space, and changing the traditional roles of editor and reviewer. Thus, redesigning practices is not simply about instituting new processes, it changes the roles and division of labour between community members [1].

Principle D: Tools are needed to support the new work practices. Tools are needed to make the publishing of link-rich web sites tractable. Many people may lack the technical skills, time, or inclination to engage in hand-crafting new digital document forms. Support is needed for automating the tedious and error-prone parts of the document creation process and to make it accessible to non-technical participants. Tools should be designed to make a good first approximation and then allow for humans to refine and correct the tools’ output. The challenge is to create tools that are supportive, yet do not hinder the formation of new practices.

THE D3E TOOLKIT AND DOCUMENT INTERFACE

D3E consists of tools for generating and managing a site, and tools supporting the document interface (Figure 1). The Publisher’s Toolkit is a Java™ application that takes HTML files (hypertext mark-up language) as input and parses these files to create new HTML files with special forms of navigation and integrated discourse facilities. The look and feel of a site is defined by creating a set of HTML template files containing D3E-specific variables that indicate where different kinds of document contents should go. In the document interface, the discourse facilities use a tailored version of HyperNews [17] (written in PERL) that we have modified to suit our design principles.

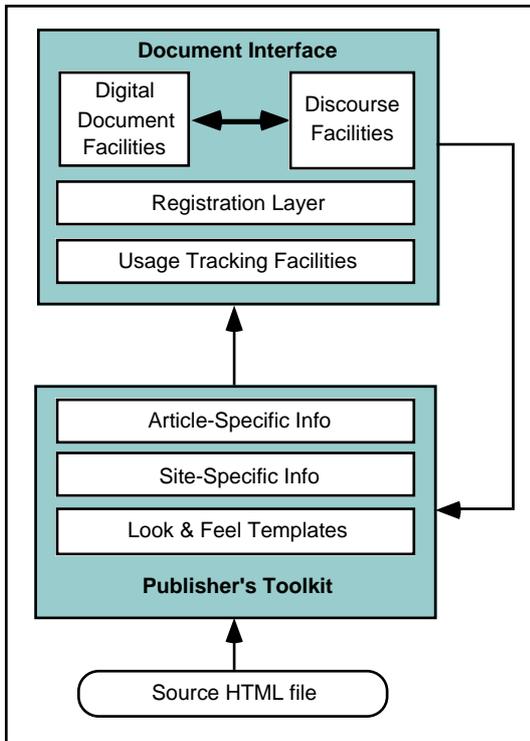


Figure 1. The D3E architecture.

We'll illustrate the basic functionality of the toolkit and the document interface using a simple scenario. Imagine a distance education setting where a tutor has asked a group of students distributed over a large geographic distance to jointly discuss a paper. The tutor imports the HTML file into the toolkit on her desktop computer by selecting an input file (Figure 2). Next, she specifies article-specific information by filling in the form with the relevant details.

On hitting the "Go" button, the toolkit takes the source HTML file and generates a new set of HTML files, creating the document interface shown in Figure 3:

- Comment icons are embedded in each article section which take the reader directly to the relevant area of the discussion space.
- An active table of contents is constructed for navigating around the article. Using the depth specified in the 'header level' field in the toolkit Article form, the toolkit parses the source file to find all <H1> and <H2> header tags and uses these tags to create the table of contents.
- The toolkit parses the source file looking for possible author-date or numeric citations. Where it detects citations, it establishes two-way links between citations and their corresponding bibliography entries. If the toolkit is configured to do so by the template files, citations and footnotes can be displayed under the Article frame when a citation link is followed.
- The source file is split up into smaller, faster loading files corresponding to sections in the article, and

Figure 2: Article-specific information for generating the table of contents and splitting files is specified in the toolkit Article form. The Publications form is used to configure site-specific information such as the templates specifying the site's look and feel and standard topics for discussion.

navigation buttons to the previous, next, and top sections are inserted at the foot of each file.

- A 'downloads' page is created, where for instance, print versions or any required plug-ins can be placed.
- Any hypertext links in the original document(s) are preserved; i.e., they still point to the same contents even though the file structure has changed.

The toolkit also generates a discussion space (right window, Figure 3) linked to the document, providing:

- An outline structure of headings matching the paper's section headings;
- Areas for general discussion (defined by the tutor in the toolkit's Publications form) are inserted at the top, for comments not specific to a particular section.
- Links back into the different sections of the article to facilitate smooth navigation.

All of this file processing is done locally, on the tutor's computer. If the tutor is not satisfied with what the toolkit has produced, she can continue to iteratively refine the document interface since the toolkit can take its own output files as input.

When she is satisfied, she moves the set of output files onto her web server and announces the location to her students. Students can now add review comments to the site by selecting a review heading, entering their comment and pressing the 'submit' button on the form provided. Students can optionally classify their comments as ones that 'agree' or 'disagree'.

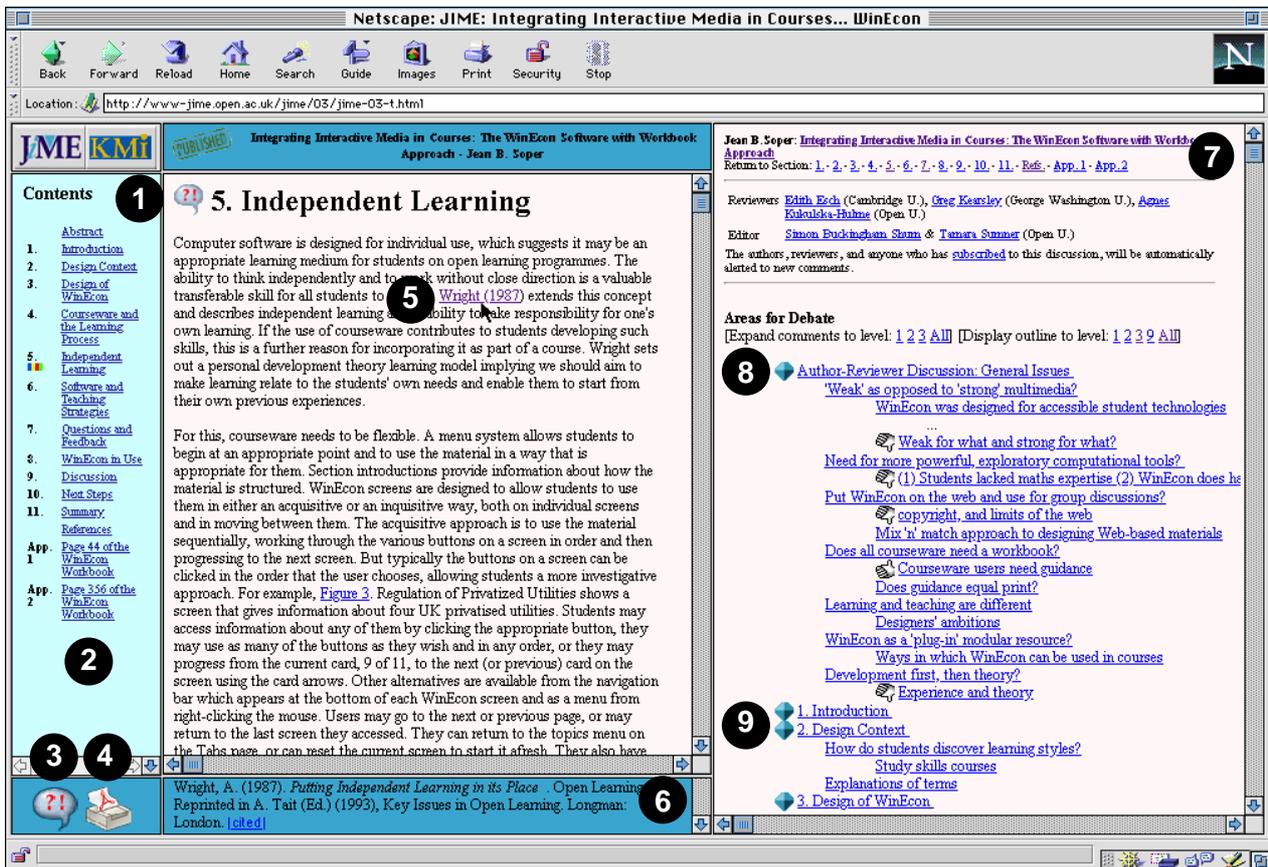


Figure 3: Output of the D3E toolkit from a source HTML article. On the left is the Article Window, on the right the Commentaries Window showing the top level outline view of discussion about the document. Key: [1] Comment icon embedded in each section heading: displays section-specific comments; [2] active contents list; [3] icon to display top level discussion outline, as shown on right; [4] icon to download Acrobat version; [5] citation automatically linked to reference in footnote window; [6] reverse link to citation; [7] links back into article; [8] general discussion heading defined in toolkit; [9] headings for section-specific comments. (Note that there are two versions of the user interface: one with tiled windows as shown, and one with overlapping windows for smaller displays).

This simple scenario illustrates how the D3E toolkit and document interface satisfy several of our design principles. First, with regard to *Principle A*, the discussion area is based on a very simple, and optional, classification scheme. All additions are classified as 'comments' by default unless 'agree' or 'disagree' are explicitly chosen. Second, with regard to *Principle B*, the toolkit embeds links in both the document and the discussion area for smoothly navigating between the two representations. The links in the document are section-specific, taking the user directly to the relevant area in the discussion space rather than to the top-level discussion page. Third, with regard to *Principle D*, the scenario demonstrates how the toolkit made constructing a site with rich linkages tractable for one person and without requiring detailed knowledge of HTML. For most documents, the publication process takes less than half an hour.

The tutor could have customized and refined the toolkit's output in a number of ways:

- The look and feel of the site can be customized by modifying the template files.

- The toolkit works in two passes which are controlled by the 'insert break markers' (pass 1) and 'split files' (pass 2) boxes shown in Figure 2. The first pass places D3E-specific tags into a copy of the source file. The second pass produces the final HTML files based on these tags. The user can stop between passes and tailor the D3E tags to modify the toolkit's output.
- The toolkit tries to automate tedious work such as automatically linking citations and references. However, there are occasionally 'potential' citations it cannot resolve. The toolkit presents the user with a list of these potential citations and their surrounding context. Thus, it automates what it can, and provides useful output for the user to take over when it can't.

This scenario also shows *Principle C*: the work practices of distance learning students has been redesigned to emphasise collaborative critiquing rather than individual analysis. We'll now illustrate Principle C in two scholarly contexts—an e-journal and a new form of conference.

CASE 1: JIME

We have been using D3E to publish an e-journal, “The Journal of Interactive Media In Education” (JIME). JIME is targeted at researchers and practitioners in educational technology, both in school and workplace settings. JIME has been in operation for one year and is available free of charge at [14]. Besides being a forum for work in educational technology, JIME was founded with two additional goals. First, rather than simply reading about interactive media, we wanted readers to directly experience the systems being described. Second, we wanted to foster discussions between participants from diverse backgrounds and geographic locations. We now go back in time, before the toolkit existed, and describe its co-evolution with new work practices as we tried to realise these goals.

Creating a Seed

We began by creating the D3E document interface, and decided to use the output from the review process to create an initial discussion seed. Reviewing was done in the traditional manner by independent reviewers. We then combined the reviews and entered them into the discussion space to create an initial discussion seed.

We constructed the first site, containing a single article ([8]) and its discussion space, from scratch by authoring HTML files. This article contained two embedded demonstrations that were constructed by the authors using Director™ and Shockwave™. We applied Principle B and embedded the demonstration directly in the document so that readers did not have to download a demonstration and ‘run it’ separately from the document (see Figure 4).

We announced this site to a limited audience (the JIME editorial board and participants of the London 1996 HCI conference) and the site received 20-30 visits a day during the open review trial period (September 1996). The

purpose of the limited announcement and trial period was to gain feedback on our document interface and give us experience with the publishing process, which we could improve on before scaling up our efforts.

Analyses of the log files during the trial indicated that the document interface was promising; readers were using the embedded demonstrations and viewing the associated commentary. Several participants contributed to the review debate. We viewed this as positive support for design Principle B, because other e-journals with demonstrations and commentary that do not provide tight integration have reported little use of either facility [18].

Eliminating Extra Work

Unfortunately, the production process had been quite demanding – requiring several days to produce the document interface (i.e., the navigation and discourse features shown in Figure 3) and to verify that the results behaved correctly. This did not include work associated with the interactive demonstrations. Clearly, this amount of per-article effort was not sustainable; tool support for the process was needed to make the publishing of the journal tractable for a small team (three people working part time). We refined the initial document interface and constructed the first version of the D3E Publisher’s toolkit (containing only the Article form shown in Figure 1).

For the next two submissions, we used the toolkit to create a hidden web site and modified the review process. Reviewers entered their comments directly into the discussion area at the hidden site and authors were encouraged to participate. This change promoted a more dynamic debate, as reviewers and authors responded to each others’ comments. Figure 5 shows part of a review where the key ideas of one submission were debated.

Submissions were open for public review for a one month period. While readers can add comments after this period, as a stated policy, only comments made during the period will be taken into account when producing change requirements. It is too early to be sure, but we appear to get more reader contributions during the open review period than afterwards. Knowing your comment can affect the published article may provide incentive to contribute.

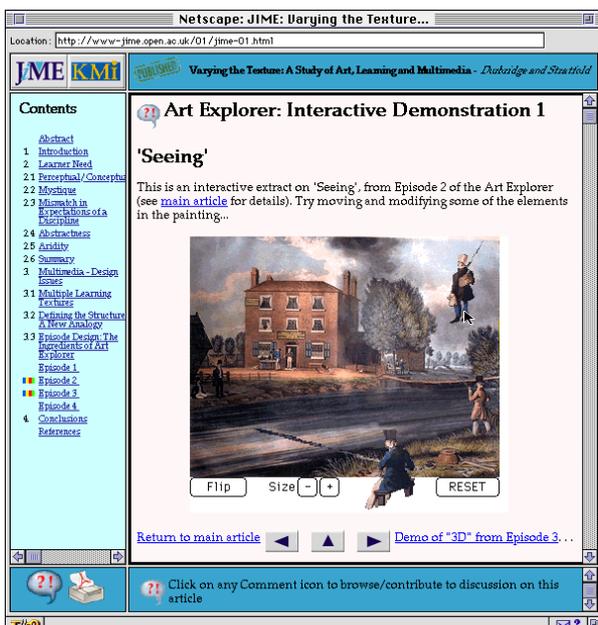


Figure 4. The interactive demonstration is embedded directly into the document.

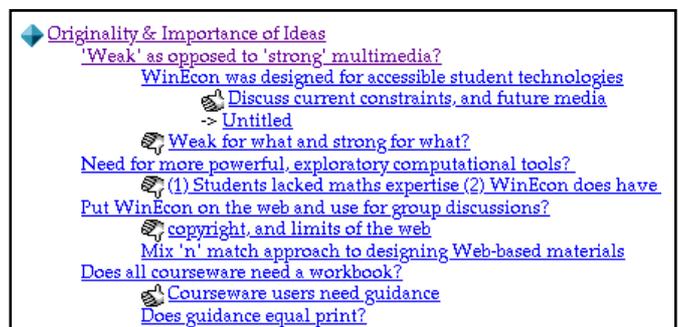


Figure 5. Outline of a thread in a review debate. ‘Originality and Importance of Ideas’ is a standard discussion category. Five of the contributions are from reviewers, five are from the author, one is from the editor, and two are from readers.

New Roles and Division of Labour

Figure 6 illustrates the current article lifecycle in JIME. This lifecycle changes the traditional roles and division of labour in the journal review process. The entire process is structured to promote discussion between participants, and to generate an initial discussion seed prior to the article becoming available to the public. The editor's role is to facilitate and moderate the discussion, and manage the discussion space. As usual, editors generate change requests for authors. In JIME, these change requests take the form of hypertext accept/reject letters with embedded links back to the relevant parts of the discussion space.

At a superficial level, the publisher's role looks similar to paper-based publishing models; i.e., the publisher is marking up and making available the document. However, now the publisher creates two versions – the initial review site and the published site. This additional labour would not be feasible without a toolkit to automate most of the production process. The toolkit has dramatically reduced the time and effort to mark-up articles by several orders of magnitude: a process that took days by hand can now be done in minutes. In several cases, this aspect of the publisher's role has been assumed by the editor, and even by authors themselves wanting to fine tune the presentation of their work.

In the case of JIME, we believe a publisher role is still important even though most of the production process is automated or assumed by other participants. Many authors do not have the time or technical expertise to publish their interactive demonstrations on the web; journals wanting such components must be willing to provide technical assistance. To do so, publishers need new skills and knowledge concerning multimedia production and web publishing tools. In effect, publishers become a form of domain-specific 'translator' [19], working with authors to help them present their work effectively using interactive media. To assist in this process, we are also enriching D3E with tools to support the publishing of interactive components. One such tool, based on [22], enables authors

to create narrated slide shows which can be used to give readers a guided tour through a typical use scenario.

CASE 2: LEARNING.ORG

The learning.org conference was hosted by the Office for Technology Development at the Open University. The goal of the conference was to consider the implications for United Kingdom (UK) universities of the Dearing Report recommendations [6]. Most participants were senior management staff with responsibility for the strategic direction and use of information technology within their university. Others were members of the committee that drafted the Dearing Report. Altogether, there were about thirty-five participants dispersed throughout the UK.

The Office for Technology Development wanted to use the web to enhance the value of the conference by enabling participants to make the best use of their limited face-to-face meeting time. A multi-site, three stage event with the following structure was conceived:

- Stage 1: A half day opening plenary with three speakers.
- Stage 2: Two weeks of discussion on issues raised in the plenary and in the Dearing Report.
- Stage 3: A one day meeting organised as discussion sessions around topics emerging from the previous two stages and closing plenary.

Figure 7 shows how this three stage event was carried out using a range of communication technologies. The opening plenary session consisted of a live webcast using KMi Stadium [22]. The three plenary speakers gave slide-supported talks, much as they would at any conference. Using Stadium, the talks were delivered to participants at their own universities. Using a standard web browser, participants were able to view the slides, hear the audio speech, and ask questions in an associated chat window (left side, Figure 7). As presenters switched slides, a textual marker such as "Slide 4" was inserted into the stream of comments in the chat window.

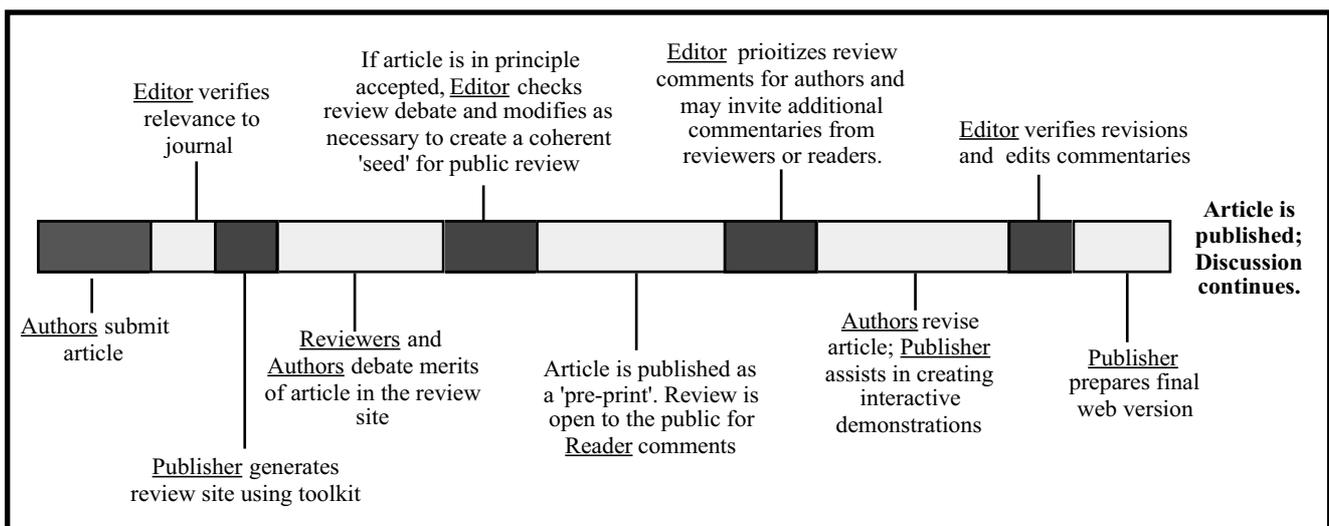


Figure 6. Lifecycle of an article under review in JIME.

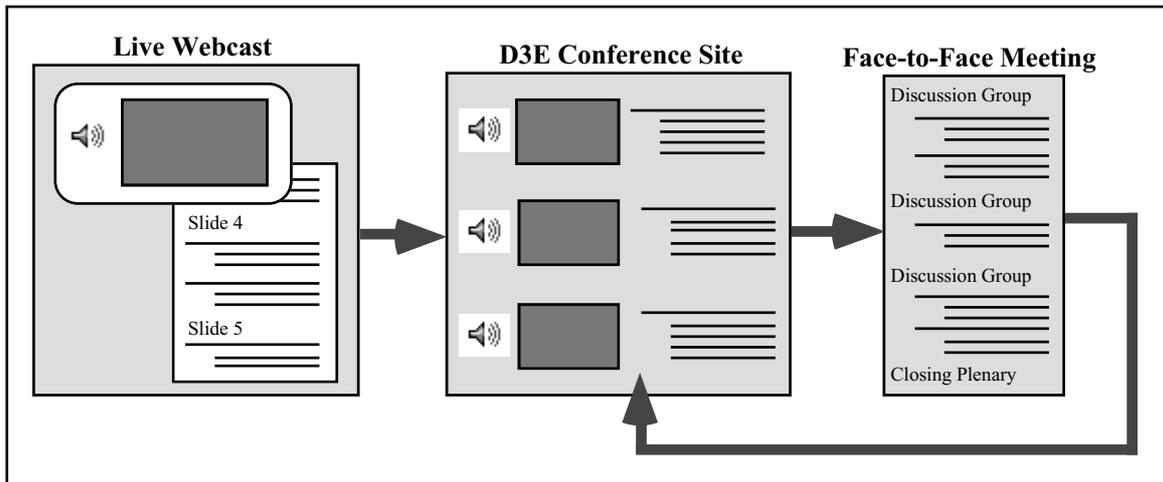


Figure 7. A new conference form: the structure of learning.org.

We used the output from the live webcast to create the initial seed for the D3E portion of the learning.org event – Stage 2. The documents published in D3E consisted of the speakers’ Powerpoint™ presentations, the audio portions of their talk associated with each slide, and any comments from the chat area in the webcast (centre, Figure 7). We used the textual markers to determine the locality of comments from the webcast; i.e., comments made between the “Slide 4” and “Slide 5” markers are associated with slide 4. Slides from two of the speakers were not available until just before the webcast. Using the toolkit, we were able to publish the three slide documents and the seeded discussion space in just over a day.

Now, the face-to-face portion of the conference is able to take on a different role. Rather than focusing on delivering presentations, Stage 3 is devoted to active discussions on key topics. By supplementing these discussion groups with dedicated note-takers, the output from this stage is again, fed back into the D3E discussion space.

This process changed the roles of both the conference organisers and the participants. Participants are able to take on a more active role. In the plenaries, participants were raising and debating questions amongst themselves in the chat window *during* the talks. Rather than running out of time to discuss the issues raised (as often happens), there is plenty of opportunity to reflect on and refine the issues during the subsequent two week discussion period. The upcoming face-to-face meeting provides motivation for participants to continue to add to the ongoing debate.

Conversely, this model also requires new activities from conference organisers. Similar to JIME, with the help of the Publisher’s toolkit, the production effort shifted from simply making documents available (whether papers or copies of slides), to making the discourse surrounding the documents available in an integrated interface. Our efforts were centred around quick bursts of live event, post-production activities. The goal during these bursts was to take discourse from one media form (i.e., the webcast or the face-to-face meeting) and transform it as quickly as possible to support the next stage.

CONCLUSIONS

In summary, we have described several scholarly contexts where we have used D3E to realise discourse-centred publishing practices. Using D3E, the effort behind the publishing process shifts: from making documents available, to supporting the generation and transformation of the discourse surrounding the documents. What often starts as fairly conventional document forms (e.g., a text document from a word processor converted to HTML, or a slide presentation) are progressively enriched as surrounding discourse is reified and embedded back into the documents themselves. Sometimes the discourse takes on alternate media forms such as interactive components or audio clips. The new publishing models were made possible by a combination of tool support and the redefining of participant roles. As part of this research, we have articulated four principles which we believe are useful for others considering new forms of electronic publishing and computer-mediated debate.

In [28], Veltman claims that ‘recontextualising the parameters of quality’ will be a key challenge facing the next generation of electronic media consumers and producers. Current publishing models emphasise document presentation in a final archival form, after lengthy and hidden deliberations. Using technology, we are considering alternate notions of quality that include making explicit other aspects of documents such as timeliness, history, and intellectual lineage. In these models, documents continually evolve to reflect the latest work, the latest event, and the reflections of others. The criteria for quality expand to include the richness and currency of the extra context. With this enriched context readily available and integrated into the document form, readers are in a better position to judge for themselves the work’s relevance and quality.

This research raises many difficult questions which we can not yet answer. As future work, we will continue to build tools enabling radical process changes, to apply and refine our principles in new contexts, and to probe people’s perceptions of the utility and desirability of these alternate conceptions of scholarly publishing.

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REFERENCES

1. Bellamy, R., "Designing Educational Technology: Computer-Mediated Change," in *Context and Consciousness: Activity Theory and Human-Computer Interaction*, B. Nardi, Ed., MIT Press, Cambridge, 1996, pp. 123-146.
2. Brown, J. S. and P. Duguid, "The Social Life of Documents," *First Monday*, Vol. 1, 1996, <http://www.firstmonday.dk/issues/issue1/documents/>
3. Buckingham Shum, S., "Analyzing the Usability of a Design Rationale Notation," in *Design Rationale: Concepts, Techniques, and Use*, T. P. Moran and J. M. Carroll, Ed., Lawrence Erlbaum, NJ, 1996, pp. 185-215.
4. Buckingham Shum, S. and N. Hammond, "Argumentation-Based Design Rationale: What Use at What Cost?," *International Journal of Human-Computer Studies*, Vol. 40, Iss. 4, pp. 603-652, 1994.
5. Buckingham Shum, S. and C. McKnight, (Eds.) World Wide Web Usability: Special Issue, *Int. J. Human-Computer Studies*, Vol. 47 (1), pp. 1-222, 1997.
6. Dearing, "Higher Education in the Learning Society," <http://www.leeds.ac.uk/educol/ncihe/>, National Committee of Inquiry into Higher Education, UK, 1997.
7. DeRose, S. J., "Expanding the Notion of Links," *Proceedings of the ACM Hypertext'89 Conference*, Pittsburgh, PA (Nov.), 1989, pp. 249-257.
8. Durbridge, N. H. and M. P. Stratford, "Varying the Texture: A Study of Art, Learning and Multimedia," *Journal of Interactive Media in Education*, 96 (1), <http://www-jime.open.ac.uk/jime/01/jime-01.html>, 1996.
9. Fischer, G., A. C. Lemke, R. McCall and A. Morch, "Making Argumentation Serve Design," *Human Computer Interaction*, Vol. 6, Iss. 3-4, pp. 393-419, 1991.
10. Fischer, G., R. McCall, J. Ostwald, B. Reeves and F. Shipman, "Seeding, Evolutionary Growth and Reseeding: Supporting the Incremental Development of Design Environments," *Human Factors in Computing Systems (CHI '94)*, Boston, MA, 1994, pp. 292-298.
11. Grudin, J., "Evaluating Opportunities for Design Capture," in *Design Rationale: Concepts, Techniques, and Use*, T. P. Moran and J. M. Carroll, Ed., Lawrence Erlbaum Associates, Hillsdale, NJ, 1996, pp. 453-470.
12. JAIR, *Journal of Artificial Intelligence Research*, Morgan Kaufmann Publishers, <http://www.cs.washington.edu/research/jair/home.html>.
13. JILT, *Journal of Information, Law and Technology*, University of Warwick and Strathclyde University, http://jilt.law.strath.ac.uk/jilt/issue/1997_2/default.htm.
14. JIME, "An Interactive Journal for Interactive Media," *Journal of Interactive Media in Education*, 1996, <http://www-jime.open.ac.uk/>
15. KMi, "Dearing Report Discussion Site," 1997, <http://kmi.open.ac.uk/Dearing/>
16. KMi, "learning.org," 1997, <http://kmi.open.ac.uk/learning.org>
17. LaLiberte, D., "HyperNews," 1995, <http://union.ncsa.uiuc.edu/HyperNews/get/hypernews.html>
18. Libtech, "Reports from the Electronic Libraries Programme," *Conference on UK Electronic Journals on the Internet*, University of Hertfordshire (Sept. 5), 1996.
19. Mackay, W., "Patterns of Sharing of Customizable Software," *CSCW'90: Conference on Computer-Supported Cooperative Work*, Los Angeles, CA, 1990, pp. 209-221.
20. McKerlie, D. and A. MacLean, "Reasoning with Design Rationale: Practical Experience with Design Space Analysis," *Design Studies*, Vol. 15, Iss. 2, pp. 214-226, 1994.
21. O'Day, V., D. Bobrow and M. Shirley, "The Social-Technical Design Circle," *Conference on Computer Supported Cooperative Work (CSCW '96)*, Boston (Nov. 16-20), 1996, pp. 160-169.
22. Scott, P. and M. Eisenstadt, "Stadium: Experiments in Real Telepresence," in *The Knowledge Web*, M. Eisenstadt and T. Vincent, Ed., Kogan Page, London, 1998.
23. Shipman, F. M. and R. McCall, "Supporting Knowledge-Base Evolution with Incremental Formalization," *Human Factors in Computing Systems (CHI '94)*, Boston, MA (April 24-28), 1994, pp. 285-291.
24. Sumner, T. and J. Taylor, "New Media, New Practices: Experiences in Open Learning Course Design," *In Human Factors in Computing Systems (CHI '98)*, Los Angeles (April 18-23), 1998.
25. Sumner, T. R., N. Bonnardel and B. Kallak Harstad, "The Cognitive Ergonomics of Knowledge-Based Design Support Systems," *Human Factors in Computing Systems (CHI '97)*, Atlanta, (March 22-27), 1997, pp. 83-90.
26. Terveen, L., P. Selfridge and M. D. Long, "From 'Folklore' to 'Living Design Memory'," *Conference on Human Factors in Computing (Interact '93 and CHI '93)*, Amsterdam (24-29 April), 1993, pp. 15-22.
27. Turoff, M., U. Rao and S. R. Hiltz, "Collaborative Hypertext in Computer-Mediated Communications," *Proceedings of the 24th Hawaii International Conference on System Sciences, Volume IV*, 1991, pp. 357-366.
28. Veltman, K., "Frontiers in Electronic Media," *interactions*, Vol. 4, Iss. 4, pp. 32-64, 1997.