

1. Title "Distributed Digital Multimedia Materials : towards new document centred user interfaces?"

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2. Abstract

The focus of this discussion is "electronic publishing" and the new converging computer-based technologies, tools and methods for the organisation and delivery of the "electronic page". The new generation of distributed digital information product will need to exploit features made possible by digital technologies such as hypermedia, advanced user interfaces which provide both viewing and construction facilities, multitasking multiprocessing operating systems and distribution on the network. There is a new arena for information designers - between the "printed page" and the "interactive display". "Consumers" will require tools supporting their navigation around information space and for information retrieval and editing. "Providers" will require tools for the organisation of resource, the management of multiuser composition and distribution, and the customisation of tailored information product. These issues will be considered within the context of current developments in distributed multimedia systems, and with reference to some on-going work in my group into general purpose mechanisms for multimedia "applications" and the prototyping of an environment for the realisation, development, distribution and management of applications providing access to multiple users on the network.

3. Introduction

Technology developments, including CD-ROM and networking, have encouraged organisations to pursue the idea of the "electronic document" and a new format for publishing and distribution. While multimedia publishing on CD-ROM with a number of world standards is already a growth area, new developments in technology and the emergence of the first wave "world wide web browsers" e.g. Mosaic, are providing an interesting environment for the development of a new generation of "electronic publishing" (or do I mean "distributed multimedia applications"?). The transition from printing press and paper to digital information resource and the screen requires a new approach to the design, composition and distribution of digital information product and the generation of revenue.

A challenge to the developers of the new technology and the tools is to encourage new mind-sets and to work with publishers in the development of better tools - enabling them to explore the new technology-based working practices and strategic business operations which will be required for the new generation of electronic information product. In my view, essential to the notion of "electronic document" is portability, distribution and multiple access, and the encapsulation of a variety of user operations and requirements. This requires sophisticated technologies and tools which support distributed computing by multiple users on networks.

The "document" can be thought of as a composite of components. Some of these components can be used to describe its structure for the purposes of display. Others to describe the contents - for the purposes of representation, communication and editing. Content is logically any type of information, any medium, in any combination. In addition to structural and content components, various system components will be required for the

distribution and management of the document on a network. Modular and component design, development and delivery environments (including techniques of object-orientation) are providing a new generation of solutions.

From a system and application developers viewpoint there are interesting generic features which are common to the tasks and technologies for the publication of electronic documents e.g. an on-line technical manual, and the delivery of applications providing access to multimedia information e.g.. technical databases and training materials. This is especially so when the materials are in a multiuser distributed system on the network. There are a number of issues to be addressed in the implementation of such systems, including scaling; the management of complexity; distribution with high performance to multiple simultaneous users in a controlled fashion; and the provision of easy to use, attractive and engaging interfaces. Such interfaces should include general support for navigation of hypermedia structures, communication between the various users, and support for a variety of more specific tasks and activities, including the organisation and sharing of resources among work groups. The educational context provides a fertile area for exploring the general features of paper-based and computer-based communication. It is a focus area for electronic publishing and the development of a new generation of teaching and learning materials - in which holders and generators of copyright resource will work with publishers to organise and distribute digital as well as paper-based materials

Hypermedia publishing on the network is a new opportunity : a medium for continuous distribution and multiple access. Traditional publishers are becoming increasingly aware of the possibilities, but it has not been clear exactly what the best strategies and appropriate technologies and tools are. More familiar with the control of the printing press and the economies of printing books and journals, the new digital superhighways and client-server enterprise computing on the network present an exciting new opportunity, but whose operational and cost parameters are yet to be established. The focus of much current R&D, the telecommunications technology and infrastructure guaranteeing end-to-end service is yet to be established and provide a standard business platform.

The various technical, cognitive and societal dimensions of designing and delivering digital multimedia materials into business and the home go beyond the page and the screen display and involve new paradigms for communication and cooperative working within information systems. The challenge is to design for the coexistence and the integration of the traditional paper-based and the new digital media, and to create new tools which will exploit the novel and powerful dimensions of digital media and enable smooth transformation between different representation media and different delivery platforms.

4. What is an "electronic document"?

While the book and the printed page is a powerful metaphor for the document, what is the metaphor for the digital entity which can combine written text, speech, displayed static and dynamic images, film and music? Is it a database; is it a document; is it multimedia; is it hypermedia; is it interactive; and does it do the trick?

It might be argued that the document is an obsolete idea, just one traditional window onto information which will be replaced by new data visualisation tools. However, the paper document has a long history, our culture includes a whole set of conventions and rules for representing reality and communicating knowledge in such form, and it will be a significant storage and communication medium for some time. People have an emotional attachment for paper. They like paper-copies of drafts and high quality brochures - with information set out usefully in conventional fashion; easily

accessible in the briefcase.

However, while people are naturally document readers rather than database users, the

culture is changing, with the computer providing a new dimension of interactivity. The ideal printed paper document and the ideal screen display are different entities. Reading lots of text on screens is not ideal; scrolling is not good for you it can drive you crazy. Special tools and special skills are required to exploit the possibilities for searching and retrieval of digital information. The electronic document is not just a means to record information but is a way of interacting with it.

Digital media has an ecological appeal - with the potential to reduce the destruction of tree-resource for paper-making - suggesting the need for an electronic substitute to paper as a major vehicle. In 'The Turing Option' by Harry Harrison and Marvin Minsky (*Warner Books Inc., 1992; ROC : Penguin Books 1993*) such an entity is described - "eternitree paper developed for a daily newspaper... looks like and feels like ordinary white paper tough plastic that has been textured to feel like paper, with a bonded thin-film surface. Which means it is almost indestructible and completely re-usable." Electronic access to digital information in an instant, and at multiple locations, needs to include structured support for browsing and the creation of linkages.

Key requirements include the effective location, retrieval, re-purposing and redirection of information. These facilities are offered in principle by digital media, although there has yet to evolve a complete solution to the provision of support for the browsing process and a variety of information modelling tasks. The digital solution should include the advantages provided by paper browsing such as the seeing of other interesting things on route, together with flexible means for formulating new links and new information structures.

The paradigm of hypertext and hypermedia is basic to the design and structuring of such digital media resources and applications. The "hypermedia document" is a multidimensional entity of no particular size or complexity which through an interface can provide a variety of access to readers and writers. The hypermedia document might be a book, a magazine/journal, a point-of-information browser, or a courseware module. Getting lost in hyperspace, both as a browser and as an author of hypermedia systems is a natural tendency. Varieties of access, composition, and interaction support tools will be required as components of such systems, including the support of editing, management and distribution in the publishing of multiple- authored documents, and the support of pedagogical communication between teacher and student in the delivery of courseware.

The pressure for better ways to communicate electronic documents is growing. In the library documentation field the rich paper document is called the "primary document" and the Holy Grail is to access, retrieve, and transmit the primary document in electronic form. In the healthcare field the distributable "multimedia patient record" is the Holy Grail, and in the educational field the distributable "courseware module" is a similarly sought after entity. Other domains will require similar entities.

5. Implementation

There are a number of recently emerging utilities and prototypical standards which are important to the development and commercial uptake of distributed digital multimedia. These include file compression, storage and retrieval formats such as JPEG and MPEG for pictures and video. Also needed are utilities for the description of the structure and format of organised information in a generic fashion so that the information can be handled independently of the technology. A common medium is required to encapsulate and distribute the diverse formats of bit-mapped image, text bases, word processor files, ASCII text, spreadsheets etc. between users, machines and programs in a transparent fashion.

Among the standardisation processes which have been pursued are SGML and PostScript. The SGML (Standard Generalised Mark-up Language) format is defined in an ISO standard (ISO-8879) and was originally developed in a project to match the structure of technical documents to the structure of the systems being described e.g. a

document to describe an aeroplane. SGML does not describe the appearance of the document but is designed to express the deep structure of the information and to enable transfer of documents to different environments; it is oriented towards the delivery of the printed document. Used in the publication of the Oxford English Dictionary, it is however felt by some users to be too complex and unfriendly. PostScripta was developed by Adobe as a page description language for laser printers and typesetters.

There is considerable interest in the creation of a universal format for the distributed electronic document, not dependent on any particular tool or technology. An increasing number of products support the new Acrobat PDF (Portable Document Format) from Adobe by embedding 'pdfmark' calls in their PostScript output, or by producing PDF directly. Acrobat is intended to extend PostScript from printing anywhere to reading anywhere. Ordinary PostScript files do not contain structural or hypertext navigation information. An Acrobat document can be considered as an electronic paper document; pages can be viewed, inserted and removed, with 'sticky' notes as comments on content; as with a paper document there is no capability for manipulating the document's content below the page level. Other added-value electronic features of the format are : selectable thumbnails of pages, bookmarks with nesting to represent chapters, sections and subsections (analogous to menus), links between pages, word searching, scaling of pages to any part and viewing to fit to window or fit to width of pages. The 'sticky' notes enable users to add comments to documents in lieu of editing.

This new format is being used in a number of projects including UK Mail International's Electronic Newspaper project and the CAJUN project in the UK, and a number of others in Europe and beyond. Among the basic concerns of such projects is maintenance of electronic form during passage of material from publisher to printer and the support of communication on the network.

UK Mail International's Electronic Newspaper project was aimed at the development of a specialised electronic news reading PDA (Personal Digital Assistant). The idea is that newspaper readers connect the PDA to the telephone network in order to access the latest edition of their favourite newspaper (similar to the MIT Electronic Newspaper project in which the idea was that information is constantly updated from diverse sources). Multimedia extensions to the paper version can be provided, such as a video-clips of the winning goal in the world cup final which could be launched by selection of the static picture.

The CAJUN project (CD-ROM Acrobat Journals Using Networks) based at the University of Nottingham, jointly funded by Chapman and Hall and John Wiley, has been concerned with the production and dissemination of Scientific, Technical and Medical journals using the Acrobat format**.

***Smith, PN, et al Electronic Publishing - Origination, Dissemination and Design 6(4) 481-483 Proceedings of the EP'94 Conference*

The commenting facilitated by the yellow-sticker annotations provided by the Acrobat format was of particular interest in this journal project. For the newspaper industry the PDF form provides significant value as a format for archiving. However, extra (electronic) features were identified as essential to support the process of production and distribution. Of special interest were features which could be defined and created by authors, to be carried throughout the production process in a transparent way.

The Esprit Multos Project identified the potential utility of having several structural descriptions of a multimedia document in order to support different operations. In this component model approach, which employed the ODA (Open Office Document Architecture) format to specify office documents including presentation information, there is distinction between a physical layout structure and a conceptual structure. The physical structure, which is

delivered to the output device at presentation time, has components such as pages, frames and blocks and support for the operations of editing, formatting, presentation and exchange. The conceptual components of a document are useful in document creation and querying. The Acrobat PDF has been devised to control the addressing mechanism between the conceptual and the logical structure of documents.

5. What are the new problems and challenges?

"The ability to author a document and simply print it on paper is no longer adequate in today's business environment. Users must be able to distribute information electronically throughout an organisation and across multiple computing platforms." (Geraldine Kelly, Vice-President Frame Technology Europe).

Interest in portable document file formats such as Adobe 'Acrobat', Farallon 'Computing Replica', No Hands Software 'Common Ground' and WordPerfect 'Envoy' is being driven by the need to provide for the accurate rendering of documents across multiple platforms. There is considerable interest in document management tools, compound document architectures and the integrated desktop - with document management synonymous with file management, data access, data presentation, and the document manager as the user interface. The emerging term "middleware" describes a layer of components which link front-end-ware (client tools) with back-end-ware (back-end services). Examples of "middleware" are SoftSolutions Document Desktop and Lotus Notes - providing group access and leverage for document management.

Structured publishing packages - 'Ventura Publisher' and 'FrameMaker' - provide tools for the creation of document templates for paper and screen. These are combining the attributes of desktop publishing (for document structure with hypertext) and databases (for storage and retrieval), with customised views for electronic or paper distribution. Postscript files generated in 'Frame' can be distributed through the Acrobat format. Corel 'Ventura Publisher' supports 'Acrobat's' links, bookmarks and annotations. 'FrameMaker' has its own facilities for creating hypertext documents, rather more powerful than 'Acrobat's'.

6. What are the potential directions and solutions?

What will the next generation of digital media look and feel like, who will have access, and what are the most fruitful applications?

What is the situation visualised in 'The Turing Option'? "There is a hyperbook coming on to the market that is about 3/8ths of an inch thick and contains only ten pages. The edge binder contains a really powerful computer that controls a detailed display on each page, one that is even more detailed than the pages of printed books. When you finish reading page ten you turn back to the first page, which already contains new copy. With a hundred megabytes of memory this ten-page book will really contain a quite substantial library." "The system has a learning scheme... does content analysis and records descriptions of the subjects that interest you .. the system gets better and better at profiling your interests... every subscriber gets his own special newspaper".

In a programme of work which has been conducted over the past few years in my group at the University of Leeds, an approach to this problem has been the investigation and development of "information modelling tools" - with a focus on portability between machines, distribution on the network, and high performance delivery with easy access by multiple users in a cooperative operational environment.

7. The GARDEN model

GARDEN is a prototype which has evolved in an applied approach to the development of generic information modelling tools. This has involved end- users in a variety of subject-matter domains and projects, developing multimedia point-of-information and educational applications. Some of the features of the GARDEN model will be compared

with some of the key issues confronting developers and users of "electronic publishing environments".

The GARDEN prototype was developed to meet the need for a computer-based foundations course, to be developed by multiple authors in a matter of months, and to be accessible by dozens of students on unspecified machines on an institutional network. An application development and distribution environment was required that would facilitate the importation of materials (documents with pictures and text) generated by authors, the organisation of a digital multimedia resource model, and the delivery of an application with browsing access enabled in an attractive, engaging and simple to use interface. Using the technologies of UNIX, X11 windows, Sun Microsystems Sparc, and re-using some components from the earlier prototype 'Media Language', the GARDEN prototype was rapidly developed.

The new generation object-oriented programming language 'Eiffel' was used to specify a formal model and to construct libraries of classes of objects encapsulating useful features of the operating system and display models. The application is delivered to the user through the agency of a client, given the correct i.d. and

permission, by a GARDEN server. The first prototype has the appearance of an "electronic book". The client interface provides the user with access to a "map" of the application. Information is displayed on "pages" through user interaction with nested menus and the selection of icons and objects of interest. As well as this "framework" access to content, the user can also select various text items within the displayed page and go to an "index". Access back into the content can be arbitrarily defined and linked from an index item. User interaction is monitored with time-stamped logging. The tasks of constructing and customising the framework is separated from the tasks of importing and editing the content. Content is allocated to the framework by an editor. The design and semantics of the framework is specified by the domain expert and is constructed and customised by a digital information designer. This provides a representation of the application to the end-user, who is provided with organised access to content. The framework for application content is generated following the simple hierarchical UNIX file model. Application templates can easily be generated from a model. With branches formed from organising nodes of more complex objects, the leaves on this tree can be defined as individual modules of content e.g. the tree : Dickins Works, Letters, Novels, A Christmas Carol, with the leaf : Forward. Content is marked up by the editor : pictures are inserted by reference and text is marked up for format and presentation, including selectable (hypertext). Once edited, an application resource tree can be compiled and with the correct permission it can be run as a distributed application, using the services of NFS, to multiple users on the network. The distribution model is flexible and multiple client applications can be run by the GARDEN server. The client needs to cope with being displayed on a variety of screens (in this case capable of displaying an X window) and GARDEN adapts the display size dynamically. The target display size for the first prototype courseware application was 1024x768 in view of the probability that the client would be delivered to PC's - which would require colour 8-bit screens with the SVGA display. At this size, and a higher resolution of 1152x900, pages from the prototype display three columns of content; at 640x480 only one column can be displayed and the number of pages increases accordingly to present all content.

The current prototype is undergoing further testing and development. Users will want more varieties of access and interactivity e.g. within the educational context, students will want bookmarks and other personal navigational aids and they will want to cut and paste, personalise and re-use materials; in pedagogical terms, they will need testing with informative feedback with adjustment and redefinition of interaction plan. Editors will want easy to use tools providing visual, iconic and direct manipulation access to content and its organisation. Framework constructors will require simple and flexible tools for customising presentation and enhancement of the interface.

8. Conclusions

The printer and the interface designer are approaching each other through the medium of information technology and there will be a metamorphosis

from print to electronic delivery. The computer-based approach to communication, and the graphical user interface (and by extension the hypermedia user interface), includes metaphors from the real world for information delivery and access. These include (from windows, desktop, workspace, menus, network, to instrument control panels, documents etc). One trend might be towards new document centred user interfaces.

New metaphors and new paradigms are needed and are being developed to encapsulate the notions of digital information base, querying, presentation, editing and distribution. The "hypermedia document" might be the new vehicle for publishing authored and edited works and databases on the network. A dynamic entity, with presentation modules, snapshot views and printed versions as static entities. The digital hypermedia system provides new possibilities and opportunities for interactivity and distribution. A new means of communication. These will necessitate control and guidance mechanisms, and mechanisms for controlled access.

A key list of electronic document and system attributes is : scalability, portability, distributability, interoperability, reusability. With attractive and engaging access, which is comprehensible and enables enjoyable and informed use. A general set of solutions for the publisher of electronic documents is equally applicable to distributed multimedia digital materials on the network - be they electronic journals, multimedia patient records or distance learning instructional courseware modules. The functionality required needs powerful computing and some sophisticated and leading edge technologies. These include the UNIX operating system and RISC machines. Such powerful computing is becoming recognised as essential for the support and implementation of complex large-scale information systems offering multiple users high performance graphical and multimedia interfaces and a variety of access in transparent fashion. The multitasking and distribution services provided by the UNIX operating system are becoming modelled in the new generation of systems such as NT and Chicago.

Hypermedia systems are inherently multiuser, distributed, and large-scale. Hypermedia applications have much in common with "electronic documents" and key implementation issues are generic to both. These include scalability, distributability across platforms and multiusers supported within cooperative working environments. "Hypermedia-in-the-large" systems should support: (i) an open philosophy, (ii) the integration of tasks as well as information (inter application linking), (iii) collaborative applications, (iv) heterogeneous environments, (v) across network linking, (vi) versioning of data, (vii) public and private links, and (viii) access control**

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In the process of addressing these issues, object-orientation as a technique for the representation and management of complexity, is being applied to the problems of hypermedia systems implementation. Object-oriented models may be better than relational models to describe multimedia information. Object-orientation encourages high levels of abstraction, analysis and design combined with lower-level descriptions of classes of system and application objects, and it is increasingly becoming adopted as a development strategy in large scale systems. OODBMS (object-oriented database management systems) can provide features such as authorisation, version control, locking, and long transaction management, which become essential in large, complex evolving information systems with a variety of end-users with differing needs and skill levels.

In the development of the GARDEN prototype we have employed UNIX, open systems client-server computing and OOT to the design, development and testing of working systems with end-users. The "end-user" simply wants attractive, high quality and

engaging interfaces (with familiar objects) which are easy to use. In terms of a client-server model, the client interface should be configurable and customisable and provide general navigational support and a choice of tools for a variety of tasks. As well as a viewer of electronic documents, with tools for locating and retrieving information, the client requires tools for application construction and content editing. The server must provide a number of services, including support for querying on the network and the administration of multiple clients, with access control and monitoring. The access, the services and the information are all potential revenue generating components.

The technology is rapidly evolving, complex and the choices are very difficult to make. The new generation of information systems will be complexes of integrated components rather than single or monolithic programs, and the task is integration of "best-of-breed" technologies and tools.

Back to the future world of the Turing Option, "with eternitree you can print the book you want, slip the sheet into a spring binder and sit in the sun while you read". The visions of Vanaver Bush and Ted Nelson coming true.

Paper is a tactile, traditional and personalised artefact. It could be used more sparingly. The aesthetic dimension in handling text and other printed media cannot be ignored and can be designed for in an electronic form. To integrate with rather than replace the paper document; to provide a vehicle not just for printing, but a hypermedia resource, organised and accessible in a thousand and one ways.

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