The Challenges of using the World-Wide Web in Teaching History of Science

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Introduction: David J Mossley *PRS-LTSN, University of Leeds*

This briefing has arisen largely as a result of a seminar and workshop held at the University of Liverpool in September 2002 to discuss challenges in using the World-Wide Web in teaching and communicating the history of science to university students and the public at large. The workshop was organised by the Philosophical and Religious Studies Subject Centre of the Learning and Teaching Support Network (PRS-LTSN). All the participants are concerned with how the Web can be best integrated into scholarly and informed use by students and lecturers in higher education and by the general public. Although most of the articles published here have also been presented or published elsewhere, they are key to the discussions in Liverpool and represent a diverse range of views on the use of the Web in the history and philosophy of science.

Issues of quality are right at the heart of these discussions. Whether Web material is to be used in scholarly researches or as a model for the construction of websites for assessment purposes, there is no immediately obvious standard by which students can judge the quality of on-line historical discussion, reviews or digitised documents. So much material exists that is not to the relevant high standards scholarly discussion requires that the need for the kinds of discussion promoted by the PRS-LTN is urgent and in most cases welcome.

Graeme Gooday (p. 5) gives more fully the case for debate and describes some of the options open to busy teaching academics. He bases his analysis on an earlier PRS-LTSN workshop. Louise Jarvis and Joe Cain (p. 11) show us some new and exciting ways for using the Web for assessment—encouraging students to construct their own Web resources helps them acquire a range of skills, not least how to better judge what could be appropriate for high-quality argumentation of historical and philosophical points. Their article is the third in a series looking at assessment in the history of science. James Sumner (p. 23) takes different approach and argues that we need to revise the basic principles of how we present Web resources to the world at large, not just to students, arguing that we should encourage students and colleagues to bibliographise rather than merely catalogue resources. Finally, Ann Borda and Robert Bud describe three projects at the National Museum of Science and Industry that aim to share history that makes the best use of the Web in the communication of ideas to a wider audience and provide us with some though-provoking models.

PRS-LTSN

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The Challenge of Using the World-Wide Web Resources to Enhance Students' Learning of History/Philosophy of Science Technology and Medicine

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Many of our students are now very familiar with the World-Wide Web and are at least moderately adept in navigating around it. They use its multifarious resources in preparing History/Philosophy of Science, Technology and Medicine (HPSTM) essays whether their teachers want them to or not. It would be futile to try to stop students doing so since they would probably continue covert use of Web resources and perhaps be tempted to plagiarize them if teachers tried to prohibit citation of them. So teachers must surely accept that students now see the Web as a permanent feature of their learning experience and work with this rather than against it.

Prima facie higher education (HE) teachers of HPSTM need to adopt some sort of explicit strategy for dealing with their students' use of Web resources, specifically to help students to *optimize* the use of such resources in their learning experience. Yet this is not a challenge to which all HPSTM teachers have yet given full consideration. This might be because not all are aware of the extent of students' Web-usage and indeed some are disinclined to discuss the topic lest they appear to sanction the use of Web-materials that they often (rightly) consider to be of a low quality.

"… teachers must surely accept that students now see the Web as a permanent feature of their learning experience …"

The justified concerns of teachers about the inappropriate use of Web-resources in student learning is particularly apparent in relation to *introductory* level courses since students taking these will often have had no previous familiarity with standard textbook literature on the subject. At a Philosophical and Religious Studies Subject Centre (PRS-LTSN) workshop in Leeds in May 2001, a wide variety of views were expressed by UK HE teachers of history of science, technology and medicine on this hotly contested topic:

i. Students on introductory courses should be discouraged from consulting websites.
ii. Students on such courses should not be encouraged to cite Web sources in their essays.
iii. Students should not cite Web sources in essays at least until they are familiar with the scholarly use of conventional textual resources, and only then with proper guidance on which Web sources can be trusted and how they can be used.

iv. Students can cite Web sources in essays so long as they are given adequate guidance on which sources can be trusted and how they should be used.
v. Students can be trusted to be astute and critical consumers of visual/video Web materials, and so should be encouraged to use Web resources in essay writing so that they can build up their confidence in handling texts before learning to read more traditional textual forms.[1]

There was some optimism expressed at this workshop that students (and teachers) could optimize their use of the Web in the learning and teaching experience by using the RDN on-line Tutorial 'Internet for History and Philosophy of Science' developed by James Sumner and Nik Jewell.[2] As admirable as this tutorial is, its use in self-help training is probably best undertaken with a clear sense about the opportunities to embrace and the dangers to avoid in using the Web. And indeed one outcome of that workshop was for HSTM teachers to agree that one useful task that the PRS-LTSN could undertake was to provide them with supportive guidance on the most effective means of using Web-resources in their own teaching.[3]

The following lists are a set of observations made by colleagues, postgraduate students and myself on these two issues designed to meet this need.[4]

Here are the optimistic and pessimistic views to consider:

How using Web sources might be able to enhance students' learning of HPSTM

1. Students who feel intimidated by the prospect of searching for HPSTM books or articles in a conventional library in preparing an essay might be more inclined to read around the subject using Web resources, and thus produce higher quality written work.
2. Access to on-line versions of primary sources can easily be managed by teachers, and students encouraged to read them with greater dedication and depth if thus available.
3. Easy Web access to on-line versions of important HPSTM secondary sources spares both students and library staff the difficulty of managing peak demands for library copies. This is all the more important now that there are good quality free access on-line journals e.g. *First Monday*.[5]

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[1] Graeme Gooday, 'Report on a History of Science, Technology and Medicine Workshop, Leeds, 30-31 May 2001', in *PRS-LTSN Journal*, 1(2001), pp.61-76, quotes on pp.70-71. This report is also available on-line at **http://www.prs-ltsn.ac.uk/hist_science/articles/hstmrep.html**

[2] **http://www.vts.rdn.ac.uk/tutorial/hps**

[3] Ibid, p.76.

[4] It should be reasonably clear from the context whether the opportunities and dangers I discuss arise either from intrinsic features of the Web or from the kind of practices that Web-users employ in surfing the net.

[5] **http://www.firstmonday.dk/**
See also the archives of *Ends and Means*, **http://www.abdn.ac.uk/philosophy/endsandmeans/**

4. Where the Web provides on-line versions of valued secondary sources, less advantaged students can to some extent use these to alleviate the need to spend money on photocopying or buying the relevant text books e.g. MendelWeb[6] online version of Bruno Latour's famous article 'Give me a laboratory and I will raise the world' is also. [7]
5. Literature searches on a given topic are greatly enhanced since many libraries and course-reading lists provide on-line bibliographical information. Thanks to the altruism of many scholars in HPSTM many important sources and recommended readings can be traced relatively quickly.
6. Uniform standards of good practice can be developed by sharing reference to globally-available Web sources, e.g. advice on plagiarism at the Cambridge History and Philosophy of Science 'Research Methods' advisory page for students. [8]
7. Students might be better able to use quotations in their work: quoting from Web sources can be much easier and quicker to achieve than from paper sources—just cut and paste!

The pitfalls of students' excessive or uncritical dependence on the www in learning HPSTM

1. Web-centred learning in HPSTM can usually (or at least currently) expose students only to a small selection of the important primary and secondary resources in any given area. The vast majority of relevant Web-pages offering second sources—at least those not already published in reputable on-line journals or on-line version of pieces previously published in hard copy—are of lower rather than high quality. Low-quality on-line primary sources are often those that are inaccurate or ineptly bowdlerized and low-quality on-line secondary sources tend to be those that are 'unscholarly' or naively simplistic in style. Such , all too often offering outmoded historiography that is progressivist, triumphalist, positivist, determinist Whig history etc.; importantly such sources only appear to be up-to-date because they are available on the www with exciting graphics and stimulating colour-schemes.[9] Thus the calibre of scholarship that students encounter on the Web will typically be a great deal lower than if they use a conventional text library, and if they do not make the effort to read other sources, the quality of their work may suffer accordingly.
2. A closely related point is that students can develop habitual uncritical dependence on secondary sources that can entail many a simplistic understanding, conceptual errors and misspellings. Students persistently fail to grasp that such material is not freely available on the Web is because it is good and trustworthy—on the contrary usually it is not of sufficient quality to be published more formally elsewhere.
3. Much more likely, it has been produced by hobbyist amateurs with few scholarly qualifications—indeed there is nothing to stop anyone engaging in Web publishing

[6] **http://www.netspace.org/MendelWeb/**
[7] **http://www.stanford.edu/dept/HPS/SciMedOrg/Sources/GiveMeALab.html**
[8] **http://www.hps.cam.ac.uk/research/fpage.html**
[9] I'm very grateful for suggestions offered by James Sumner and Steve Sturdy on these points.

on HPSTM. This point is ably addressed in the 'Review' section of the HUMBUL Internet Tutorial on History and Philosophy of Science[10]. Students that persistently lean too heavily on Web-resources, and become accustomed to doing so, will not become familiar and adept with browsing libraries and handling books and journals. They will thus not be well prepared for essay writing and research projects later in their academic career that require them to exercise skilled library usage.

4. Students can develop an undue trust in the competence of those who prepare Web-sources, especially in transcribing and or translating primary sources—unless students learn to compare with some version closer to the original source.
5. The convenience of cutting and pasting text from www material makes it much easier—and perhaps more tempting—for students to engage in plagiarism, not withstanding the prevalence of well-known search engines to detect such plagiarism. The Web cannot be blamed for 'causing' such plagiarism, but the enormous ease of using the Web for this purpose is not to be underestimated.

"… secondary sources are the most worryingly attractive to novice students seeking a quick solution to meeting an essay writing deadline …"

6. The supposed advantages of the Web offering free access to learning materials are somewhat nullified by the problem of on-screen reading: it is notoriously very difficult to read scholarly material directly from a monitor. For those who suffer this problem, the obvious solution is to print the material out to read at leisure. Yet the cost of printing a text from a networked computer can be greater than it is for photocopying, thus there might after all be little financial advantage accruing to Web users after all.
7. The common teacher's presumption that students do actually have ready access to www resources can be invidious and even generally false. Most universities do not supply computing resources that enable full Web access for each and every student for most of the day, nor can all such students (especially those from economically disadvantaged backgrounds or with disabilities) obtain their own computers and internet access. It is thus unreasonable and unfair ever to require students to use Web-resources with no alternatives in any formative and summative assessment process—teachers do all an injustice if they make false assumptions in this regard.

Possible solutions to the pitfalls identified above

1. As teachers we can develop strategies to overcome or at least circumvent these dangers to student learning: providing incentives for good Web usage, imposing penalties for poor usage, and supporting students who have difficulty gaining access to the Web at all.
2. When setting coursework assignments, teachers could opt to recommend—in addition to conventional textual sources—that students use and cite from some high quality on-line versions of primary or secondary sources, giving clear advice on the correct citation of such materials. They could perhaps even allocate marks

[10] **http://www.vts.rdn.ac.uk/tutorial/hps**

specifically for the competent fulfilment of these tasks, while at the same time giving credit for using and citing from an appropriate amount of conventional textual material from libraries and textbooks.

3. Teachers should ensure that students who do not have ready access to the Web (e.g. through personal financial circumstances or visual disability) can have relevant materials available in some suitable alternative form without any financial penalty.
4. Students could be specifically advised against using any Web source not recommended by their teacher. They could perhaps even penalized for citing unapproved sources, unless they can show to the teacher's satisfaction that the source uncovered by the student is of a suitable quality.
5. Teachers can tell students how easy it is for them to trace Web-plagiarism by search-engines, and perhaps indicate how many cases of plagiarism have been detected and punished in the past. It might even be helpful to show specific examples of exactly how easy it has been to detect such plagiarism.[11]
6. Students should be given some clear guidance on the pitfalls of using the Web in an uncritical manner—and well before they are at risk of losing marks in assignments through such poor practices. For example, in addition to using the RDN Internet tutorial cited above, they might be given examples of how poor quality Web sources create or perpetuate major errors, over-simplify or mislead, and misquote or mis-transcribe important texts. They should also be given some advice on what sorts of things students cannot get expect to get from the Web i.e. what can only be obtained from reading hard-copy texts, from doing their own hard thinking, and from debating with peer group and teachers.
7. Teachers can make available on-line their own scholarly writings (with permission of publishers as necessary) or much-used primary source materials that they or their students find valuable for the purposes of learning and teaching, and encourage colleagues to do likewise. There are fortunately already some projects underway to promote such access, e.g. the Victorian Web[12] and the history of phrenology[13]. *The British Society for the History of Science* is planning to make available more such sources through its Wheeler Library. But given this is so it is important not to duplicate efforts, so it would be prudent to engage in some careful consultation before going ahead with a large-scale project of placing sources on-line. One effective model of how to proceed is the *Starry Messenger* site maintained by the History and Philosophy of Science Department at the University of Cambridge. [14]
8. One way of combining together several important features of the above is to use Websites in the process of summative or formative assessment. Students might for example be given the task of evaluating on-line resources (of whatever quality) by comparison with standard scholarly sources.[15] That way they can be motivated to look for the differences for themselves, and in the case of summative assessment be given credit for doing so. Joe Cain and Louise Jarvis at University College

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[11] **http://www.indiana.edu/~wts/wts/plagiarism.html**
[12] **http://65.107.211.206/victov.html**
[13] **http://pages.britishlibrary.net/phrenology/**
[14] **http://www.hps.cam.ac.uk/starry/starrymessenger.html**
[15] Steve Sturdy has suggested getting students to compare popular Web biographies of Joseph Lister with Lindsay Granshaw, 'Upon this principle I have based a practice' : the development and reception of antisepsis in Britain, 1867-90', in J.V. Pickstone (ed.) *Medical Innovations in Historical Perspective*. Basingstoke: Macmillan, 1992, p. 17-46.

London have come up with further suggestions for constructive techniques of using www resources in student assessment.[16]

Conclusion

The Web can be used to good effect for enhancing some aspects of learning and teaching in HPSTM, but not all aspects—the Web is no universal panacea! While students have a responsibility to obey the rules that their University and their teachers lay down in regard to Web usage, it is the responsibility of teachers to help all their students make the best use of Web resources or at least to help students to minimize that harm done to their learning by inappropriate uses of the Web.

The above suggestions might constitute one possible set of strategies to achieve effective use of the www in student learning. But there might well be many other approaches to be adopted—HPSTM teachers who use the Web a great deal are hereby invited to contribute to this debate. Please contact Graeme Gooday at **g.j.n.gooday@leeds.ac.uk** .

If anyone wishes to undertake research into student usage of the Web resources for learning HPSTM, they may apply to PRS-LTSN for funding to do so by contacting the PRS-LTSN administrator Simon Smith at **s.g.smith@leeds.ac.uk** .

Details of previous successful bids for funding are available at:

http://www.prs-ltsn.leeds.ac.uk/grants/index.html

[16] See URL **http://www.ucl.ac.uk/sts/cain**

Web Projects in Undergraduate History of Science*

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Introduction

This is the third paper in a series on diversifying assessment in undergraduate history of science programmes (Jarvis and Cain, 2002; 2003). This paper considers the use of assessable projects that either use or create Web-based resources.

Our project on promoting diversified assessment involves a survey of existing literature from the educational literature and a synthesis of practical advice on the design, implementation, and likely problems while introducing these concepts into an overall assessment strategy.

Use of the Web in course assessment is controversial in the history of science teaching community (Gooday, 2001) but, we think, for no good reason. Computer and information technology (C&IT) skills are key skills. Students use the Web extensively.[1] Parents and employers expect graduates to be adept users. Information access through libraries increasingly emphasises on-line outlets. Learning and Technology Minister Michael Willis explained in 2001 that people need C&IT skills "in almost every job. And a successful Britain needs them too" (BBC, 2001a). Tutors have a firm responsibility to develop these skills in their degree programmes.

Our consideration of Web projects distinguishes evaluation and construction, then divides construction into design and implementation. This compartmentalisation provides a deliberate progression in which students develop skills sequentially. Tutors don't need to accomplish all C&IT goals in one step and easily can combine Web projects with more familiar assignments.

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[1] A late 2002 Egg survey found Internet use had increased to 42% of all adult Britons, 19 million people, with use by women up ten percent in the past six months (BBC, 2001b). Web and IT use is highest among those under 35 and in other adults among those in higher socio-economic group (BBC, 2001a). Certainly some have no interest in these skills. In national surveys of all adults, *Which?* Online reports nearly a third of those surveyed claim to have no plans to use the internet, claiming it is either too expensive to use of "has nothing relevant to their lives." Yet 64% claim the internet "has become part of every life" (Ward, 2000).

Definitions

On a basic level, Web sites consist of a series of linked documents. Each document (one Web page) combines text, graphics, and links to other documents located either within the site or located in other sites.

In Web site evaluation, students assess Web based resources as texts using critical reading and analytical skills. They also consider strengths and weaknesses of resources based both on principles of Web site design and on features distinct to the medium.

Constructing Web sites involves two phases: design and implementation. By the end, students can expect to have created texts and graphics, locate relevant additional materials, then combine these into Web pages. They link multiple pages together into a functioning Web site. In Web design, students plan site components and consider overall site architecture. Implementation involves assembly and programming.

Web site construction can be used as the final stage of a research project that might otherwise produce a research paper. Web sites can be produced by groups or by individuals, with varying degrees of credit attached to design versus content. Web sites can be submitted on diskette or published through a course Internet site.

Benefits

C&IT skills are ever more important key skills (UCL, 1999–2000) and increasingly tied to "graduateness" (HEQC QEG, 1995). Degree programmes normally respond by encouraging rudimentary literacy and familiarity: use of electronic libraries (especially databases and on-line replacements of printed materials) in research, word processing for writing, and e-mail for communication. This basic training is admirable, but students are entering higher education with increasingly sophisticated average C&IT skills (c.f. BBC, 2001a; Kent School District, 2001). Support staff within universities normally offer basic and supplemental skills training, such as preparation for the European Computer Driving Licence.[2] Tutors in degree programmes should press on: combining subject-specific skill development with further C&IT training.

In many departments, student use of Web based resources for research is a controversial subject (Gooday, 2001). Those rejecting the use of on-line resources argue an increasingly untenable position. A June 2002 OCLC survey reports nearly 80% of students use Web resources for most or every assignment (OCLC, 2002). Also, publishers and libraries are shifting to on-line circulation, and high quality on-line resources are far more common than several years ago. The situation on-line now mirrors the long-standing situation in print: quality varies across a wide spectrum.

"The situation on-line now mirrors the long-standing situation in print: quality varies across a wide spectrum."

Students need skills for separating the wheat from the chaff. They need to develop skills for identifying reliable versus erroneous sources and they need to develop

[2] Details of the European Computer Driving Licence and sample curriculum are provided by UCL IS (2002).

technical skills for identifying methodological and historiographical frameworks. Creating projects that develop critical reading and evaluation skills will train students to be intelligent consumers of information regardless of the source. Whether these projects begin with Web based or print materials makes little difference. Indeed, advocates of extensive Web use argue additional attention to special aspects of the Web as a medium for communication will improve the student's ability to judge the effect of Web publication and monitor its effects on other kinds of communication. Tutors need to step up to the front and lead.

Focusing on Web site construction provides opportunities for students to learn basic principles of Web design and basic technologies for implementation. Students with basic skills already can be pressed further. Training students to become producers of Web based resources emphasises project design and management skills as well as collaboration. It also develops some second generation C&IT key skills.[3] Possessing these skills can prove decisive in competitive employment environments. Guzdial, et al. (1992) stress the importance of design as a key skill. Harel and Papert (1992) argue design and implementation skills in C&IT generally promote "meta-cognitive awareness" (students thinking about their own thinking processes), cognitive control (planning and self-management of the learning process), and "meta-conceptual thinking" (students thinking about the extent of their own knowledge).

Sequencing learning outcomes from evaluation to design to implementation serves student progression. For one, it allows students to apply and extend their existing skills as they press forward. More importantly, it decomposes the overall project into many skill elements. This compartmentalisation prevents students feeling overwhelmed and provides opportunities for them to master particular aspects of a large project before moving on. In this particular sequence, experience with evaluation builds intuitions for design, and fresh design skills guide implementation. Compartmentalisation also helps tutors develop projects over several assignments or over several courses. Dropping students into implementation is poor practice and leads to low value in the result.

Sequencing also serves students who begin Web projects with skills already beyond novice levels. In a sense, compartmentalisation restrains the overeager student and forces them to concentrate on mastery of single skills. This provides opportunities for skill refinement as well as for filling in knowledge gaps. Compartmentalisation also allows for more systematic coverage of fundamentals and prevents students from using expert skills in some areas to compensate for relative weaknesses elsewhere. Compartmentalisation is more likely to contribute to peer and self guided learning, better collaboration in group work, and improved validity in assessment of group work.

Web based projects lend themselves to group work (Thorley and Gregory, 1994; Hunter, et al., 1996; Jaques, 2000). They also can be supplemented by posters or oral presentations addressing the content and design of their site (Jarvis and Cain,

[3] Kent School District (2001) provides a model for placing C&IT skills within a framework of progression despite the fact their plan is developed for primary and secondary schools. Intel Corporation's (2002) "Teach to the Future" program provides teacher training for curriculum design in which C&IT skills are integrated into course units. (The curriculum outline is posted by ICT, 2002.) Stephenson (2001) considers the value of increased C&IT training within the broader framework of innovations in higher education. Ward Schofield (1995: 62–93) justifies learning with (rather than about) computers in humanities programmes as a way to support constructivist learning objectives. Her approach is bolstered by Bransford, Brown and Cocking (2000: 206–230), and Brown, Race and Bull (1999). Balestri, Ehrmann and Ferguson (1992) consider ways for even simple programming to provide highly motivating learner-centred working environments.

forthcoming-b). Publishing student work on-line contributes to an increased sense of responsibility during the project. Afterwards, it increases the sense of ownership.

Web evaluation and construction projects should improve student appraisals of fairness (Gipps, 1994). Not only does the assessment credit creative skills and encourages self-expression, but students perceive the activity to be more enjoyable than other kinds of tasks (despite the fact few new tasks need to be introduced). A student who cannot trouble themselves to locate a reading in the library might spend hours thinking about material located through the Internet or tracing sources for a Web page that will be made widely available.

Recommendations and Implementation

A well known example of student Web projects in history of science is Van Helden (1995–2001). Though useful for interesting colleagues in the potential of Web projects in course work, this site tends to present student projects as little more than written essays converted into HTML code. Barrett, Levinson, and Lisanti (2001) provide syllabus advice for courses using Web projects, but they lean towards rather complex Web programming and work within a context in which Web design is the primary learning outcome of the course. Numerous course Web sites display student projects at various levels of expertise. Barnard History (1997–2000) usefully shows an evolving level of sophistication of design and implementation skills. Other examples include Winstanley (2001), Harvey (1998), Ayers and Thomas (n.d.). Other examples can be located by Web searching using key words "student Web presentation" and "student Web projects history". Students can be intimidated by the high standard of professionally produced Web resources. Shifting to novice sites their peer assessment of models offers a far better standard for comparison. For this, Van Helden (1995–2001) is ideal.

"… skills in Web evaluation involve more skills than reading printed text."

Projects involving Web site use can be separated into three modules: evaluation, design, and implementation. These can be treated in sequence within a single course or over a series of courses within the degree. Tutors should be certain to locate their assumptions about student skill levels within a framework for progression (e.g., Kent School District, 2001) and to clearly distinguish the needs for novice and expert learners (Bransford, et al., 2000: 31–50).

On evaluation, students should consider what makes for good Web pages and sites. In some respects, Web content can be understood simply as a text to be read. Thus, evaluation makes use of critical reading skills as described generally by Fairbairn and Fairbairn (2001) and specifically by Pirie (1985). (Jarvis and Cain, forthcoming—a discuss use of essays to develop critical reading skills.) Web evaluation projects focusing on content, perspective, methodology, and historiography can substitute for tasks focusing on the evaluation of printed sources. Hollingsworth (1999), for instance, allowed students to complete either a critical review either of a printed text or a Web site, using evaluation criteria he provided, as part of assessment in an introductory course. Tutors

can select from a wide range of sites when setting projects aimed at content evaluation, especially those relevant to course topics.

Writing styles for Web sites tends to vary in style from various print formats.[4] Many scholars argue technologies such as interactivity, multimedia and non-linearity transform Web texts into different forms of communication (Barrett, 1988; Barrett, 1992; Barrett and Redmond, 1997). This suggests that skills in Web evaluation involve more skills than reading printed text. Murray (1997) provides helpful advice for introducing evaluation of non-linear narrative. Greenberg (1998) introduces the relation between reading on-screen and underlying cognitive processes. Neilsen (1995–2002) provides useful tips for reading Web sites as more complex texts. Tutors can develop these additional evaluation skills in stages: first using Web sites much like printed texts that use special features minimally, then considering more complex sites that display more significant differences from print.

Complete evaluation rubrics for Web sites tend to focus on five categories: ideas and content, organisation and design, value for audience, presentation, and technical features (such as navigation and use of conventions). Many rubrics for evaluating Web sites are accessible on-line.[5] Tutors can ask student peer groups to elaborate these categories using Web based research and a study of familiar Web sites. Alexander and Tate (1999b) and Harris (1999) provide superb guides for tutors developing evaluation criteria for many learning outcomes.

On evaluating design, Williams and Tollett (1998), Krug (2000) and Lopuck (2001) provide solid overviews of evaluation for beginners. Of the many on-line tutorials for Web evaluation, Lycos.com's (2002) WebMonkey programme is designed for beginners. Cato (2001) and Dalgleish (2000) present more advanced considerations focusing especially on "user-centered" features. Basic principles of graphic design in print are presented by Williams (1994) and these form some of the fundamental principles used in the design of Web texts. Sumner (2000) offers an on-line tutorial for use and evaluation custom made for history and philosophy of science.

As consumers of Web based resources become increasingly sophisticated, concerns over "usability" move to the foreground in evaluation rubrics.[6] McClure (1999) and Alexander and Tate (1999a; 1999b) provide extensive critical bibliographies for evaluation of complex sites and sites designed for specific purposes. Design also refers to special issues which make the consumption of information on-screen different from that on a printed page (Nielsen, 1995–2002; Greenberg, 1998; Nielsen, 2000). Students can over-emphasise the graphic arts element of Web design to the detriment of sound navigation and clear presentation.

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[4] Henning (2000) introduces key differences; Bonime and Pohlmann (1998) treat the subject in detail. Mcgovern, Norton, and O'Dowd (2001) and Kapoun (2000) provide a style guide for writing on-line that considers wider differences. Alexander and Tate (1999a; 1999b) provides some evaluation criteria for on-line writing. Reflecting on the differences between print and Web texts can parallel discussion of other differences resulting from format changes, such as that between print and broadcast journalism.

[5] Kapoun (2000) and Bakken and Armstrong (2000) provide well-constructed examples. WebQuest (2001) can be recommended for its sequenced presentation. For others, search using key words: "Web page evaluation criteria" and "Web evaluation rubric".

[6] Guides to usability range from simple (Nielsen, 1995–2002; Williams and Tollett, 1998) to complex (Nielsen, 2000; Brinck, et al., 2002) and focus on an increasing body of empirical studies concerning human-computer interactions. Students with deep interests in human-computer interactions can access this extensive discipline through (Dix, 1997). Advanced issues in design include attention to accessibility issues such as when Web resources are experienced in voice through programmes for the visually impaired. Accessibility issues are widely discussed on-line, search keywords "Web design accessibility".

Designing a Web site involves decisions about how to transform the resources a student creates or collects into Web pages and what kinds of architecture works best for the flow of information within the site.[7] Retrospective accounts of site construction emphasise the fundamental importance of design processes prior to implementation (e.g., Berger, 1998; Cain, 1999).

Design includes attention to information architecture. On one hand this involves the conceptual arrangement of information and resources which users move through to locate the information they want. On the other hand it involves the physical arrangement of information and pages within a Web site. Barrett, Levinson and Lisanti (2001) introduce the topic. Andres (1999), Rosenfeld and Morville (1998), and Phillips and DiGiorgio (1997) provide useful discussions.

Planning and design can be made operational in the story board and flow chart model described by Jolliffe, Ritter and Stevens (2001). DiNucci, Giudice and Stiles (1998: 38–67) implement this approach in an easy-to-follow presentation. Planning can vary in its depth.[8] It can involve students in issues such as a site's purpose, audience, and limitations as well as considerations such as mechanisms for evaluating a site's use and success in accomplishing its goals. These are standard concerns for commercial Web producers (Andres, 1999; Dalgleish, 2000; Nielsen, 2000). Some coverage of this stage is strongly recommended. Importantly, it requires no technical knowledge of computer programming or specialised software. It can serve as an assessable outcome in itself. Design elements (such as story boards, flow charts, and strategic plans) provide useful replacements in cases where students experience substantial difficulties with implementation or other circumstances prevent on-line work. Phillips (1997) integrates design and evaluation themes.

"A design brief replaces an open-ended assignment with an explicit standard. Students then know when their project satisfies expectations for the purposes of assessment and can make decisions on how much more effort they wish to add."

Tutors can focus student effort by using a design brief to describe expectations for the project. For projects introducing Web design to novices, a detailed brief can provide much needed guidance. It also provides a mechanism for tutors to embed principles of good presentation, navigation, and usability. Briefs for more advanced projects can focus on specific areas for skill development. A design brief replaces an open-ended assignment with an explicit standard. Students then know when their project satisfies expectations for the purposes of assessment and can make decisions on how much more effort they wish to add. Design briefs also can emphasise some skills to the exclusion of others. For example, focusing assessment on writing skills, factual accuracy, overall site integration, and navigation means the tutor sets some design features (such as elaborate graphics or complex programming) outside the learning objectives for the project. Design briefs help students maintain their focus. Implementation involves

[7] Guidance for tutors seeking to introduce assessment based on student production of Web resources is sparse. Barrett, Levinson and Lisanti (2001) is a rare exception though it focuses on courses dedicated solely to Web design, and it assumes advanced C&IT skills among the students. Relevant literature tends to focus directly on implementing particular design features or particular programming needs. This seems inadequate: akin to dropping a novice swimmer in the deep end of a pool and expecting not only to survive but also to build optimal skills.

[8] Cain (2001) provides an example of strategic planning—in this case for a departmental Web site. Barrett, Levinson and Lisanti (2001) provide examples of planning at different levels.

converting resources and designs into actual Web pages. This requires access to computer hardware and software. Basic Web implementation requires no knowledge of programming codes (such as HTML, XML, CSS, and so on). Common Web authoring tools resemble word processing programmes. Peer assistance provides an important source for skill development. University computer networks normally supply students access to particular Web authoring tools, such as DreamWeaver or FrontPage. Students may need basic training in these software tools as well as basic training using network environments. Tutors should ensure students have access to beginner manuals and relevant support materials. Hands-on tutorials improve active learning.

Potential Problems

Web evaluation and construction projects require skill development on the part of course tutors. This is particularly true for implementation. The long-term benefits of this training are substantial; however, this will take time and resources to launch. Practical advice for integrating C&IT skills into course work and degree programmes is provided by Jolliffe, Ritter and Stevens (2001), Maier and Warren (2000), and Leask and Pachler (1999). Haydn, Arthur and Hunt (2001: 173–205) present a strategic overview of C&IT competence in the classroom and a self-assessment tool for tutors regarding various C&IT skills. Kent School District (2001) provides a useful model of progression for C&IT skills.

Web implementation projects should be structured to slowly accumulate skills and material. Students might research and write text first. Next, create a single Web page. Next, consider design and create story boards and flow charts, and so on. If assigned as group work, care should be taken to ensure students cannot divide the work in ways that exclude one another from any one aspect of the process.

Tutors may need to provide advice for working within the local computing environment. Krumme (n.d.) demonstrates the kind of advice that can be useful.

Computer anxiety might inhibit some student efforts on these projects. Brown, Race and Bull (1999) report this anxiety is far more prevalent than most tutors assume and offer some suggestions for reducing these levels overall. For C&IT skills, tutors should identify the precise source of this anxiety (i.e., inexperience with computers generally, inexperience with particular software, lack of knowledge about local procedures, and so on) and direct support accordingly. Students with remedial skills can find assistance through on-line tutorials, self-help books, and training courses offered by University support staff. Assistance of peers also can be an effective means for skill development. Ward Schofield (1995) identifies many of the common barriers to student use of computers.

Another issue of fairness involves gender differences in students' responses to computer-based tasks. Brown, Race and Bull (1999) report females are consistently more computer anxious than men. While it seems that this kind of anxiety is perhaps more enduring than expected, it can almost certainly be controlled and rendered reasonable by the appropriate use of training and briefing sessions. This may lead to the added benefit that students can overcome a long term concern about using computers which will render their transition to an almost universally computer-based vocational environment less problematic.

Discussion

Like every other technical activity, use and production of Web resources are activities that can be enhanced through training. The use of on-line resources is now a permanent feature of the higher education landscape. Tutors who ignore or restrict Web use do so at their own peril. Tutors who promote critical use will avoid growing problems over haphazard use of Web resources. OCLC (2002) reports a growing sense of need among students for these critical skills. Tutors can incorporate Web evaluation into early courses as a way to promote critical reflection about the information they consume from Web sites. A progressive programme of increasing and increasingly sophisticated use not only can improve C&IT skills but also can foster an environment rich with active learning.

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A Web Development Policy for History of Science, Technology and Medicine Teaching

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It is becoming evident that students increasingly expect to use the Web as a study resource, and cannot entirely be dissuaded from doing so. This poses problems because most "historical" material on the Web does not meet the standards of academic research, and because the relatively clear demarcation lines which exist in print publications between the scholarly, the amateur and the commercial are much less obvious online. The consequent dangers of plagiarism, inaccuracy and heavy unflagged slanting are well-known.

A less striking but potentially more serious problem is the volume of online "history" which, though fairly innocuous, is unhelpful for the task in hand for various reasons—poppy presentation tending to glibness; absent referencing, or stylistic mediocrity, fostering bad habits among students; tedious rehashes of the most basic established analysis, generally offering less than the students would find in widely-available introductory print sources.

To combat this problem, the HSTM community needs to develop new online student materials which meet its own standards, as well as to sift and catalogue those materials which already exist. Yet we should not see the use of the Web only in terms of the students' own research. There is a strong case to be made for presenting materials—especially primary materials—for the benefit of those who teach, who may pass them onto students through lecture delivery, handouts and so forth.

Developing Primary Source Material

Development of primary sources online can usefully be made a priority because it is relatively uncontentious and reproduces material which is, in many institutions, simply unavailable in print. Unfortunately, it is also a tedious activity which requires some technical skill but demonstrates no particular academic attainment. A further apparent problem is that funding must be sought from bodies which (excepting the LTSN) have no specific teaching-related remit, and hence it may be argued that collection development should be geared to serve researchers' needs, rather than the needs of teaching.

However, I would argue that this second problem is merely apparent. Consider the task of a committee with a limited budget, appointed to decide which currently-undigitised texts, from across the whole historical sweep of HSTM and its cognate fields, should be digitised (a task which may to some extent be undertaken in the near future by the custodians of the forthcoming BSHS Wheeler Library). The only principle which

could unite its members would be to choose those pieces likely to be most widely-used in practice. Texts are widely consulted when they are widely discussed, and by and large it is those texts which are most widely discussed which become the subject of taught courses. Therefore, it is around the kind of "celebrity" material familiar to undergraduates that any deeper collection would have to be built: in a sense, teaching interests seem logically to precede those of specialist research communities here.

Developing Secondary and Bibliographic Material

There are obvious difficulties to be addressed under this heading. The production of competent analytical discussion or annotated bibliography for teaching purposes requires a far greater expertise than primary source transcription; yet those who are best placed to produce it—serving academics—are understandably disinclined to be drawn away from their bread-and-butter research. Seeking to make this kind of online work RAE-submissible is probably unrealistic: what is most needed for teaching purposes is intelligent précis of established literature, and that's precisely what "research" is not.

A more promising approach would be to have the task enshrined as a conventional feather-in-cap opportunity, analogous to reviewing, writing *DNB* entries etc. It is also precisely the kind of activity where graduate students can usefully be brought in—Starry Messenger at Cambridge[1] is the obvious model here.

"… we need to avoid the kind of pernicious uniform handling whereby an index or summary created from one perspective is automatically assumed to be suitable for all purposes…"

In fact, the specialist projects which have been set up in a variety of academic institutions, usually on the initiative of a few individuals, are often very good indeed, and have various approaches to the presentation of secondary content. Both the Victorian Web[2] and the MPI-WG's Virtual Laboratory[3] manage, in different ways, to integrate the storage or indexing of primary materials with useful essays and clarificatory pieces, which is perhaps the best option. There is really no need to prescribe how teachers should use this kind of site: depending on aims and needs, they may with equal success "fillet" it for useful material (with appropriate acknowledgement—we should stress standards of courtesy here) or simply hand the URL over to students and let them do the rest.

For both primary and secondary materials, the question of standardisation is important. On the one hand, the multifarious institutions which would (and in some cases already do) maintain useful projects need to communicate with each other, to avoid duplication and gain as much consistency as possible—and to ease the citation problem in any way available, perhaps by giving each source document or piece a unique number. On the other hand, we need to avoid the kind of pernicious uniform handling whereby an index or summary created from one perspective is automatically assumed to be suitable for all purposes: this is particularly significant in the interpretation of pre-existing

[1] **http://www.hps.cam.ac.uk/starry/**
[2] **http://65.107.211.206/**
[3] **http://vlp.mpiwg-berlin.mpg.de/**

resources, many of which were created by individuals or institutions who do not share the values of the HSTM community.

Approach to Existing Resources

A variety of well-funded enterprises now exists to catalogue and describe sites of potential academic value: within the UK, those with a remit encompassing HSTM topics include Humbul[4] maintained by the Humanities Computing Unit, Oxford, MedHist[5] and History On-Line.[6] Yet the stated objectives common to these make them less helpful than they could be to our community, especially from a teaching and learning perspective: I believe we, as a subject community, should be seeking *not* to *catalogue* the Web but to *bibliographise* it.

Current initiatives are dominated by the model of the "portal", or gateway: the idea is that users in a particular subject area use the relevant portal as an intermediary, searching or browsing its catalogue to discover materials elsewhere on the Web. This approach invites the "What Does It Do That Google Doesn't?" objection: most habitual Web users, if they know roughly what they are looking for, tend to go straight to a commercial search engine (most often the powerful and seemingly omniscient Google,[7]) which will offer a more exhaustive and generally faster search. Straightforward cataloguing, then, is redundant.

Portal maintainers respond that their facilities offer the advantage of guaranteed standards—in order to show up in the portal's database, a given site must have been reviewed and found suitable by the portal's specialist staff. In practice, however, selection tends to be predicated on a vague and seldom-analysed distinction between "high-quality" and "low-quality" resources, which relies on the opinions of cataloguers striving to cover huge subject areas, and gives little attention to what the user might want the resource *for*. There is still, to some extent, a techno-fetishist tendency to assume that *all* users will be "interested" in *all* websites relevant to their own communities *simply because they are websites*—the informal, generalist approach currently popular would seem bizarre if applied to print works.

With this in mind, I propose as an alternative the bibliographic model. Websites should be assessed just as print publications are now assessed: critically, sometimes comparatively, with a clear understanding that an authorial voice is involved and that assessments are subjective, and with a sense of a particular expository purpose underlying each synopsis—a friendly *guide* rather than an inventory. This would certainly take us beyond the power of the search engines: a single website might be flagged up as the definitive work and obvious first port of call in a survey devoted to one topic, whereas in a piece with a different focus it might merit attention only for a couple of minor items. Likewise, there is the potential to address different audiences differently, and here we see the obvious potential of specific guides for students and teachers.

The question of who would produce such resource guides has effectively been answered in the section on secondary material and print bibliography. Indeed, an

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[4] **http://www.humbul.ac.uk/**
[5] **http://medhist.ac.uk/** ; Wellcome Library
[6] **http://ihr.sas.ac.uk/search/** ; Institute for Historical Research

[7] **http://www.google.com**

integrated approach should be favoured: perhaps webpages should not simply refer to other webpages, but should describe the most useful available material as though the dividing line between media did not exist. This would help to get students back to the books (and journals), a consequence which must be seen as desirable until the scope and quality of online material has extended very far beyond its current state.

Engaging with Science and Culture:
Major Missions across Cyberspace to Share Good History

Ann Borda and Robert Bud
The National Museum of Science and Industry

Introduction

The National Museum of Science and Industry (NMSI) comprises the three major national museums: the Science Museum in London, the National Railway Museum in York and the National Museum of Photography Film and Television in Bradford. The NMSI as an institutional body inevitably faces issues which are specific to itself and certainly each of the museums under its umbrella will experience them in that individualised manner. However the strategic challenges that the Science Museum, in particular, is addressing in this paper are in fact general. So while we will be discussing a solution whose details are unique to one institution, it can be seen as a customised form of response to much more general challenges in the context of multimedia strategy. The paper will also provide an overview of the outcomes of partnership from working within consortia, and how the Museum is weaving multidisciplinary links across industry sectors and within the museum community.

Firstly, we shall begin with a problem which is not technical but rhetorical in its emphasis. The popularity of science and history publishing and the outstanding success of such books as Dava Sobel's *Longitude* and widespread public debate on the authority of science highlight an area of considerable public interest. As a consequence of this interest, there have arisen opportunities for scholars and even school pupils to follow up with questions, debates and lines of thought. Yet it remains difficult for either the layperson or the lifelong learner to find authoritative and rich information about the broader aspects of science and technology.

One reason for the difficulty is not just the shortage of resources, but the difficulty of configuring them. How do we communicate about science and technology in such a way that one does justice both to the broad cultural sweep of which they are a key part and at the same time do justice to the content of these disciplines—be they the objects of invention, formulae, experiments, theories or apparatus?

Meeting the Challenge

Finding ways of answering this challenge has been the major business of the history of science, technology and medicine for 60 years. A variety of successful approaches have been employed in this regard; namely, linking the social and the technical, the internal and the external, and the science and its context. In print media, the result has stimulated significant intellectual and rhetorical advances, although 'cross' linking has been less

satisfactory, especially in the area of dynamic storytelling. Web–based stories, on the other hand, have the particular strength that they enable us to mix interpretative narrative with numerous images of objects and of social scenes, legible facsimiles of original texts and even moving images and original sound recordings. The stories are often not the strictly linear narratives the book is so well designed at conveying, but nor do they need to be the entirely random walk around a database or encyclopedia. Instead they can resemble the semi-linear exploration of the museum visit and capture some of its sense of self-guided discovery and, even, personal construction of meaning and the story. In contrast to Universities with their emphasis on the extended linear narrative, Museums are unique in that they have established special expertise in the development of the rhetoric of the semi-linear story. This leaves the question: How does one deploy that expertise to best effect?

At one level we can be confident in our abilities: each year about 2 million people visit the Science Museum. At the same time we are suitably modest because this figure also means that 59 million Britons do not visit the Science Museum. We are searching for ways to address that 59 million. Multimedia offers the chance to be interactive in a way that books cannot be.

"… multimedia has provided a way forward not because it is sexy but because it enables us to meet needs that come with the business."

Another problem. We have 200,000 objects in our collections of which 90% are not on display. Many of them are in parts or sections, so simply producing catalogues would not be entirely practical. The web enables us to document a cross-section of the collections for those who want to see a representative selection of the Museum's holdings.

Another problem. How do we meet such legitimate and increasingly common expectations without incurring great expenses? In many respects, multimedia has provided a way forward not because it is sexy but because it enables us to meet needs that come with the business. Yet, the challenge still arises that we must continually advance the medium to meet our specific needs and those of our potential users.

Like many other institutions, we now have experience with online exhibits and even online catalogues. The task at present is how to effectively 'integrate, exploit develop and grow'. We must do this with an eye to quality and a particular hard-to-pin down character which is also harmonious with the overall character of the institution. We are currently intending to tackle this challenge in a joined–up way across our sites under the banner of a single vision which we are calling for the moment icon.net. In brief, icon.net will be a brand and philosophy for the family of museums comprising NMSI which will link up collections, gallery activities & exhibitions through a strategic and integrated multimedia plan and harmonisation process.

A joined-up approach

For the time being, the first stage of implementation toward a joined-up approach is the consideration of three specific dimensions:

1. facts about and images of our objects;
2. stories for a variety of audiences;
3. earning revenues.

It would be in some ways convenient to undertake projects each addressing only one of these challenges. However the truth is that none would be self-sustaining by themselves.

Instead we have chosen to engage in three projects which each share some quality of the whole but each with a different balance. These projects are designed to develop the rhetorical form of web narratives, to integrate rich factual and technical detail with context and meaning, and to potentially lead to e-commerce opportunities.

As a wider aim of a joined-up strategy, the projects will share the following characteristics and each will be:

- Story led
- Access providing
- Knowledge based
- Multichannel
- Interactive
- Resource generating

The three projects in question are: a lottery funded project (New Opportunities Fund), entitled "Science and Culture" (£1.2m), a new Treasury funded project, "Making the Modern World online" (£1.4m), and participation in the Fathom Consortium. These projects will each yield sites which will be accessed through the National Museum of Science and Industry portal and will be closely associated with a growing network of resource sites under that umbrella.

Science and Culture

Science and Culture will encompass the development of an online knowledge resource for lifelong learners and will enable the digitisation of 40,000 high end images, 100,000 object, library and visual records and more than 50 interactive learning resources and a debate forum.

It is envisioned that the end-product will become the UK's pre-eminent Website for the culture of science, technology and industry whereby it will provide lifelong learners from diverse communities with access to unparalleled collections from renowned national institutions. It will creatively facilitate learning, communication, investigation and debate on themes ranging from flight to the human genome.

The Science and Culture site will be free for anyone to access. It will provide knowledge and also the opportunity to learn how as well as what. At the same time there will be innovative trails leading life-long learners from the free content to pay to use activities. These will include the purchase of pictures but there will be much else besides, such as master-class inspired activities and resources.

Associated with Science and Culture, there are a group of consortia which will be working closely in the production of deliverables. For example, joining the Science Museum's own primary resources will be those of the Wellcome Trust library, the Royal Society and the RAF Museum. Each of these partners will be contributing to the content development of narratives and the general knowledge base underlying the website.

A broader consortium representing the physical and natural sciences, known as Science Invention and Nature (SIN), will be aiming to create a distinctive gateway to science, technology and nature in a cultural context. It will draw on diverse resources from other lottery-funded projects, namely the Science Museum, the Natural History

Museum, Wildscreen Trust and Y Touring. This collaboration will offer users a unique opportunity to cross old boundaries, revealing the complex and controversial overlaps between the natural and manmade worlds and setting them within the framework of an ongoing human experience. It will give access to nearly a half million digital records, including images, video, library records, narratives, theatrical performances, and debates on a range of themes such as Flight, Genetics and Biodiversity.

The establishment of a gateway will allow the SIN partnership of organisations to build on synergies and to improve access to a wealth of resources from different disciplines of science. Hence through the use of search engine technology, the public can investigate a single 'theme' such as 'Rates of Change' and explore cross-linked information on rail transport, digital technology, and endangered species in the form of text, images and sound recordings. Alternatively users who wish to make their own individual interpretations can search for various resources and discover the wealth of primary material that the gateway will gather together.

"… the public can investigate a single 'theme' such as 'Rates of Change' and explore cross-linked information on rail transport, digital technology, and endangered species in the form of text, images and sound recordings."

The SIN project team already has a large amount of combined experience of managing capital ventures and successful public access projects. In the longer term it is hoped that other partners might join, encouraging new audiences, and allowing the project to develop and flourish well beyond the three-year New Opportunities funding horizon.

In the shorter term, both Science and Culture and its affiliated projects will be devoted to bringing as much as possible from the 'back-room' to the screen.

Making the Modern World

Building on Science and Culture, we at the same time want to provide a more in-depth resource which interprets the root of modernity: A world which has been shaped and formed by the thoughts, discoveries and inventions of the scientists, engineers and industrialists of the past 250 years. Much of it we take for granted. Automobiles of every shape and size ferry us from place to place; computers assist us in our work and leisure; the latest antibiotics help protect us from disease; television screens entertain and inform us. Yet there is little general understanding of how we came to be the way we are. Moreover, such knowledge is often perceived as low on the agenda – both educationally and culturally.

This is the challenge of Making the Modern World online (MMW-online). The overarching task of one of the largest of the Museum's media current initiatives is to help promote a wider and deeper understanding of the modern world in which we live. Its method is through the creation of a major online knowledge resource: devised to fulfil both specific educational needs as well as broader cultural remits.

Such an ambitious agenda can only be undertaken through a unique collaboration. It will bring the Museum together with a leading Sixth form college, Peter Symons, backed by the creative expertise and technical production skills of an educational software development company.

The key output of the project is an openly accessible, public-friendly, cultural and educational electronic resource based on the Science Museum's highly successful

landmark exhibition and newest permanent gallery Making the Modern World. It will take this key national cultural asset and make its content and intellectual assets available over the internet, substantially widening public accessibility and appreciation of the 'real' thing.

Within the education sector, it will also have specific focussed benefits for A level and vocational students in the sciences and humanities, and also for their teachers. This is in contrast to Science and Culture with its emphasis on lifelong learners and non-curricular based resources. Ultimately MMW online, it is hoped, will encourage a higher, broader take-up of science and technology, helping to reverse the 'slide from sciences'. In the wider public domain, it will further act as a catalyst for expanding awareness of the role of science and technology in society and encourage an exchange of ideas on a whole range of issues and topics. For the partners and stakeholders it will form the basis of a powerful, expandable digital media programme-making resource from which several ancillary products can be derived, such as broadcast programmes, CD-ROMs and other multi-channel products.

Whereas Science and Culture is largely web-based, MMW-online will be able to draw on a wider range of up-to-date digital media technologies currently achievable, including rich media, 3D computer graphics and animation, virtual simulations, and customisable interface mechanisms which adapt to user needs, offering different levels of interactivity and engagement.

Fathom

The third of our projects will lead to the development of a pay-to-view product, again drawing on our in-house expertise and resources. This is being developed in concert with the Fathom (Fathom.com) consortium centred at Columbia University. Many of the great London Museums, the British Museum, Victoria & Albert, and Natural History Museum have secured a partnership with Fathom, including ourselves. Other members are generally universities such as the London School of Economics, Columbia and Michigan.

Fathom is an interactive knowledge site which encompasses a comprehensive directory of online courses and multimedia lectures offered by universities and cultural institutions, plus additional learning resources, CD-ROMs, publications and articles. Users can access a variety of free and pay-for course materials through Fathom and can also link directly to partner resources and/or take self-guided trails through thematic content on historical and contemporary issues.

The Science Museum already has special resources to offer in terms of outreach experience and has, to-date, produced over 30 free 'features' relating to aspects of science and technology for inclusion on the site, as well as contributions drawn from a major conference on the Victorians. As yet, however, the market for pay-to-view remains in its infancy and the Museum looks forward to be part of this growth area. In the meanwhile, institutional focus on the delivery and re-purposing of digital assets for learning and public access, which underpins projects like Science and Culture and MMW-online, are core activities in this first stage of joined-up strategies.

Next stage

As we enter the implementation phase for the three projects described above, we also need to start making strides toward putting in place mechanisms for longer term sustainability. Already we have begun to see the potential benefits of the projects in their modular and shared approaches. Some of the benefits have been immediate and others are forthcoming. These include:

- Creation of a NMSI knowledge base
- Leveraging collections information for wider public access delivery
- The standardisation of data delivery
- The development of the web as a 'virtual organisation' for the benefit of the public and for commercial venturing
- Specialised knowledge and skills transfer

Indeed, the scope of the projects has thus far proven to be their greatest strength, although there are the inevitable drawbacks. In terms of media strategy, the overarching thread is the development of the web as the public face to the joined-up plan of the Museum, and its growth and investment will be vital to support the main drivers of sustainability.

Especially in the e-world of today, the web has evolved from social space to become the principal platform for standardisation, organisational profiling, publishing, and a vehicle for branding, among others. It is not surprising, therefore, that the web is the principle delivery platform for a three pronged strategy that intends to weave partner networks and multidisciplinary links across industry sectors and within the broader museum community.

Figure 1: Prototype web page for Science & Culture

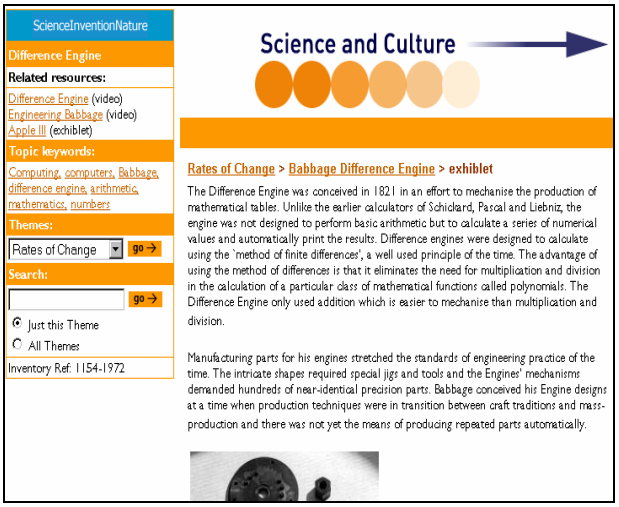

Fig. 2 Science Invention and Nature

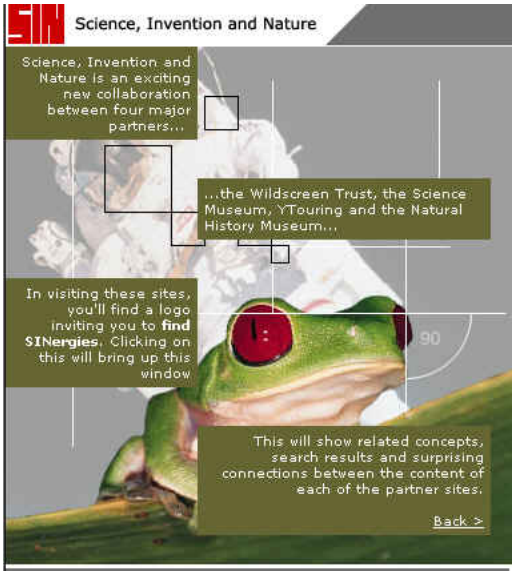

Fig. 3 Narrative structure

All three projects will be story-led and narrative structure will be a principle consideration in the construct of the final product. Below is a sample structure for Science and Culture.