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A REVIEW OF STRATEGIC ISSUES IN USING THE INTERNET FOR TEACHING AND LEARNING

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In 1998 the author published a paper entitled 'Current Issues and Limitations in using the Internet for Teaching and Learning' [1] that acknowledged the new educational possibilities provided by the Internet, while at the same time sought to identify the limitations and related issues of going on-line in education. As predicted, the passage of time and the advancement of technology have ameliorated many of the identified limitations, and, have brought new issues to the fore. This paper re-visits the area of important strategic issues in using the Internet for education, giving an overview of equity and access, infrastructure and costs, copyright and plagiarism, content development, libraries and on-line information access, and other strategic issues. As in the earlier paper, this paper draws on the experiences of the author in conventional and off-campus university teaching in engineering.

THE INTERNET AND EDUCATION

The strategic importance of information and communications technology in education is widely acknowledged, as is the key role of the Internet in enabling networked, interactive and connected learning experiences [2]. While the Internet encompasses a range of network communication services including file transfer protocol (FTP), Telnet, Gopher and network news; the services that have come to dominate the application of the Internet in education are e-mail and hypertext transfer protocol (HTTP) – HTTP is the underlying transport protocol for world wide web (Web) content. The Internet is also the enabler for the many complete courseware systems that provide content development, delivery, assessment and administration functions in a common environment, via a generic Web interface and/or a custom client program.

The use of computers in education is particularly relevant to engineering education, as the computer has become one of the central tools of the practicing engineer, whether it be for computer aided drafting (CAD), project planning, process control, budgeting, data

communications or software development. Ubell (2000) notes a US government report estimating that by 2002 15% of American higher education is likely to be delivered on-line, and that in 1999 40% of the money spent on corporate training in America was for on-line education. The same source identifies engineers as key consumers of on-line education, based on the short half-life of technical knowledge and the need for the engineering workforce to continually refresh their knowledge and skills base:

> *E-learning, especially for engineers and executives in technology industries, has emerged as one of the fastest-moving trends in higher education...As any engineer knows, there is tremendous pressure to keep pace with the latest technology and the newest ways of doing business...Yet few engineers have the luxury of attending classes on well-groomed college campuses. [3, p60].*

It is always important to remember that teaching technologies are not an end in themselves, only a means to deliver and support education – "*Technologies do not teach; people do*" [4, p31].

The following discussion focuses principally on a number of strategic issues associated with on-line delivery and support of teaching and learning in undergraduate engineering programs, for both on- and off-campus students. This paper does not explicitly address educational issues – some coverage of educational issues related to on-line delivery is given in [1]. The context for the discussion is the engineering programs at Deakin University, where on-campus students are principally conventional entry students entering tertiary study directly from secondary school, and off-campus students are principally mature age students studying part-time and working full- or part-time. While the issues discussed apply to both on- and off-campus undergraduate students, the impact of the issues is sometimes different. Where this is so, the difference is highlighted. While the engineering postgraduate / continuing professional development student group are not specifically considered, the issues discussed also apply to this group.

EQUITY AND ACCESS

Equitable access to the Internet and related computer resources and the possible educational benefits they provide remains an issue of concern. Australian studies have shown that the information technology (IT) skills levels and access to IT resources (including the Internet) of both students and teachers varies widely with sector, geography and socio-economic status [5] – there is a 'digital divide' evident in Australia. In higher education access to the Internet and usage of computers seems to vary between the disciplines, but in engineering students seem well placed to take advantage of on-line education. A study of commencing engineering students (both on- and off-campus) at Deakin found that:

- access to computers was reported at 100 percent;
- access to the Internet was reported at 92.1 percent; and
- regular use of e-mail was reported at 73.3 percent [6].

While it might now be reasonable to assume that all commencing engineering students have access to computers and the Internet / Web, it should be kept in mind during the development of computer-based and/or on-line teaching learning resources that there are various classes of access. Students accessing materials in an on-campus computer laboratory with wide-band Internet access will have a different experience to off-campus students paying time and/or volume charges to an Internet Service Provider (ISP) for modem-based dial-up access to the Internet.

INFRASTRUCTURE AND COSTS

Educators can no longer consider access for students and staff to IT resources and the Internet as an option. However, the costs of IT resources are reported as one of the main barriers to the development of students' IT skills [5]. A US survey of computing in higher education suggests that a majority of institutions use 'budget dust' (year end money) to fund IT expenditure [7]. Faced with the need to routinely upgrade / replace computer hardware and software, leasing becomes an attractive option that at least constrains IT costs to a fixed, known budget line item. Outsourcing can also be used to control costs, for example:

- on-line system and/or content development can be contracted out to commercial developers who already have the required development tools and skills base;
- IT support facilities (equipment maintenance / help desk / etc) can be contracted out with payment contingent on service and performance goals; and
- should education institutions provide dial-in modem access to the Internet for students (even if they charge a fee for this) when commercial ISPs exist?

Innovative models for providing students with access to the Internet and related IT services at a reasonable cost exist internationally, and are under evaluation for application in Australia. These fall broadly into two categories, with either the government or groups of educational institutions creating their own educational network infrastructure that they then share with others, including private enterprises to defray costs [8]. The emergence of 'free' ISPs in capital cities promised low cost Internet access for students and others, with many offering free access to .edu Internet sites. However, most of these free ISPs have either folded or commenced charging fees [9] [10].

As noted above, in modern engineering practice and education, software plays a key role in the design and manufacture of products and services – sometimes software is the product. Professional engineering software packages can be expensive, and while on-campus students may have 'free' access to software in computer laboratories, off-campus students may have to purchase the software package to have access to it at a remote location. Options employed to make software packages available to off-campus students at a reasonable cost include negotiation with software suppliers for special student pricing, volume discounts, or for the 'leasing' of software that off-campus students must return at the end of the semester.

It is also important to note that hardware costs, while significant, are not the principal expense in education IT systems. It is reported in the literature that in the US only 37 percent of the average school's IT budget goes to computers and related hardware; nearly two thirds goes toward training, maintenance and on-line services [11]. It is important to have IT infrastructure, but appropriate attention must also be given to the on-going requirements (and costs) of staff development and access to the Internet – computer equipment alone is like a car (or perhaps a taxi) on the information superhighway without a driver or fuel.

COPYRIGHT AND PLAGIARISM

Historically, educators have enjoyed some freedom with the normal provisions of the Australian Copyright Act in relation to print materials to be used for education. However, these freedoms applied to *facsimile* copying only, they did not extend to reproduction or transmission via electronic means. Throughout the period 1993-2000 the Australian Copyright Act was under review; one of the issues given consideration was the relationship between digital media and copyright [12]. The review was a response to concerns that the

Act was out of step with technological developments, such as electronic publication and distribution via the Internet, and that it had become unnecessarily complex [13].

In August 2000 the Australian federal parliament passed a range of amendments to the Copyright Act, which came into effect in March 2001. Amongst these amendments were the 'Digital Agenda Amendments'. The major areas of change relating to digital technology include:

- *a "broad-based technology-neutral" right of communication to the public;*
- *the "extension" into the digital environment of special exceptions for libraries and educational institutions;* [14, p1].

The intention of the amendments was to permit the digitisation and transmission via digital means, including the Internet, of copyright material that would have been permitted in print form only under the previous 'fair use' copyright provisions that applied to educational institutions. However, as of the time of writing, these amendments to the Copyright Act are only beginning to come into effect, and as there are no precedents for the legal issues arising from the new amendments, the types of materials and the modes of storage and transmission consider 'acceptable' or 'fair' by copyright holders is still to be tested. Within these constraints, it appears that the use of the Internet for education will be freed from the previous restrictions, and be placed on par with print as a medium for the transmission of educational materials.

Students with access to the Internet have the ability to cut-and-paste text and other material from a multitude of on-line sources. Without even the need to re-key third party material the temptation to plagiarise the work of others may be very strong. Plagiarism, of any form, if carefully undertaken, is difficult to detect. However, as with other forms of plagiarism, attempts to pass off the work of others sourced on-line as original can often be detected by telltale abrupt changes in writing style. The educator attempting to locate the source of material that is suspected of being purloined from the Internet has a number of strategies:

- students may dutifully list in their references the Web address (URL) of where the material was found;
- the theme of the work may provide a strong clue as to the source, for example, information about a particular corporation may have been sourced from the Web site 'www.*corporation_name*.com.au';
- a passage of suspect text or other descriptive keywords from the student's work can be entered into an Internet search engine, such as www.google.com, to generate a list of possible on-line sources; and
- there exist commercial organisations, such as www.turnitin.com, that provide, on a fee-for-service basis, a range of services to test for plagiarism in student work.

CONTENT DEVELOPMENT ISSUES

When approaching the development of materials (educational or otherwise) for the Internet, a range of development methodologies exist. Materials may be hand-coded in hypertext markup language (HTML) code using a simple text editor; this approach may be feasible for small projects, but is laborious and time consuming. More commonly, materials to be developed from scratch would be prepared using a what-you-see-is-what-you-get (WYSIWYG) editor such as Microsoft Frontpage or Netscape Composer; such programs

provide many of the features of a standard word processor and automatically produce the required HTML code. Where the material already exists in an electronic form, it is common to find that the original authoring tool will provide an option to export the content in HTML format; for example, most Microsoft Office programs provide this feature.

In an on-line system of significant size it is common to find that many pages will have the same basic format; in an education context this may occur when there is a collection of web pages for each of the study units in a course. This situation will probably lead to a resource bottleneck if all of the pages have to be centrally created and maintained manually. The key to sustainably managing large numbers of Web pages is to avoid having to manually create the source code for each page. Changes in curriculum, syllabus, staff, timetables, etc, mean that hand-coded Web pages quickly become out of date, requiring modification. Modern Web server technology (such as Active Server Pages (ASP)) means that Web pages can be created on-the-fly using templates to describe the page layout, and a database to provide the actual page content. An entire Web site for 100 units could conceivably consist of a few ASP template pages describing the common structure of the pages and a database of unit information. As long as the currency of the information in the database is maintained, the Web pages will be up-to-date. Ideally, the database(s) used should be the organisation's standard one(s), this will avoid the expense and dangers of duplicating data.

While relatively static administrative information should be easy to extract from existing organisational databases, the academic content for each unit does need to be individually authored. This process can be facilitated by the provision of tools to collect the content from academic staff and deposit it in databases, from which Web pages can be automatically generated. Such tools can be based on a Web interface, providing a familiar environment for most academic staff.

There now exist an array of Course Management Systems (CMS) that offer educators a complete environment in which to plan, develop, deliver, assess and administer their on-line course offerings, as well a managing on-line communication with students and colleagues [15]. Examples of these systems include FirstClass from Centrinity, WebCT from WebCT Educational Technologies, TopClass from WBT Systems, Learning Space from Lotus and many others. Such systems may cater for thousands of academic staff and tens of thousands of students located in many countries, and typically require dedicated systems hardware and personnel, and involve expensive licensing fees. In the US, a national survey reports that 73.2 percent of all higher education institutions have identified a 'single product' CMS standard, and 20.6 percent of all US higher education courses use a CMS [16].

The same survey identifies that over the last five years, the single most important IT issue confronting higher education institutions is assisting staff to integrate technology into teaching [16]. Installing a course management system or mandating that all study units will have on-line support will not, alone, achieve an effective and efficient on-line education program. To simply expect that academic staff with a wide variation in computer and Internet literacy and perhaps limited knowledge of instructional design principles will magically produce quality Internet courseware, without appropriate staff development, is unrealistic.

Cost / benefit analysis of any type of educational offering has historically been difficult to calculate, and justification of on-line delivery has proven to be no different. The US Department of Education has developed the Technology Costing Methodology (TCM) as a basis for assessing the cost side of the equation. The TCM model suggests that people costs outweigh technology costs – if technology is just added on, and no changes are made to the way programs are designed or managed, then you still have the same costs as before, plus the

costs of the technology [17]. The California State University Chancellor's Office has developed a costing model for technology-mediated education known as the BRIDGE model. This model suggests there are two dominant variables in determining total project costs: 1) the number of students served, and 2) the course development costs [17].

The first point is supported by Ehrmann who reports on cost analyses of creating technology-based course materials that show it is important to look at the cost per student rather than just the total cost – an expensive project to develop a template-based system for a large number of students may be far cheaper on a per-student basis than comparatively cheap developments that are very specific in content and serve only a small number of students [18].

On the second point, Johnstone and Poulin suggest sharing course development costs, but note that while many academic staff have experience in sharing academic materials in the form of textbooks, few have experience in sharing electronic course materials [17]. There exist several examples of institutions collaborating to jointly develop new engineering curricula. The US National Science Foundation (NSF) has funded a series of eight Engineering Education Coalitions (EECs) to jointly develop and deliver new undergraduate engineering programs [19]. Some of the coalitions are geographically based (such as the Engineering Academy of Southern New England [20]), some are focussed on discipline areas (such as manufacturing for the Greenfield Coalition for New Manufacturing Education [21]) and some are based on integrated / multidisciplinary curricula (such as the Synthesis Engineering Education Coalition [22]). The overarching aims of the EECs include: developing alternative education tools, curricula and delivery systems, to increase participation of under-represented groups in engineering education, and to improve linkages to secondary and primary schools. Most of the coalitions explicitly list 'teaching with technology' / 'technology-enabled learning' amongst their goals.

An interesting development in on-line courseware is the Massachusetts Institute of Technology (MIT) OpenCourseWare project which aims to make virtually all of MIT's courseware available free on-line to any user in the world [23]. This will presumably include undergraduate engineering courseware as well. However, those salivating at the thought of getting their hands on the content MIT's engineering programs to incorporate into their own on-line offerings should realise that there is a ten year timetable to make the MIT courseware available on-line, and, even though it has been announced as available free of cost, it does come with 'conditions of use'. Additionally, course material from MIT's particular context may not suit or translate easily into all end user situations. The no doubt extensive range of undergraduate engineering disciplines offered my MIT may, nevertheless, not include disciplines desired elsewhere. And, while the fundamentals of solid mechanics may not vary from country to country, if the engineering management components of MIT's programs describe the structure and processes of the US legal system, then they will be of limited use in Australia and elsewhere.

LIBRARIES AND ON-LINE INFORMATION ACCESS

In education, particularly in higher education, one area where the impact of the Internet has already had a profound effect is the library and the provision of library services. Libraries are about the provision of information, and the Internet has dramatically increased access to information and provided new means of delivering it to students and others. Developments here include:

- the ability to search the library catalogue (and the catalogues of other libraries) on-line (anywhere and anytime), and request or place a hold on desired titles;
- the ability to query and renew patron loans on-line;
- the ability to request an inter-library loan or copy of a journal article on-line;
- provision of reserve items in electronic form so that they are accessible at the same time by as many people as may need them, wherever they are located;
- access to on-line books and other publishing developments driven by the Internet; and
- access to commercial database services that provide on-line abstracting and full-text retrieval of serial titles and other material.

It is suggested that Australian university libraries face two possible scenarios: one where library provision for coursework becomes irrelevant due to complete, pre-packaged learning materials available on-line; or another where changes in the approaches to student learning made possible by the Internet facilitate (or even demand) a greater integration of library services into curriculum development [24].

While it is true that off-campus students may have the most to benefit from on-line access to traditional library resources, the benefits to on-campus students and academic staff who can access a wealth of on-line information in their office or at home outside of the library opening hours are hardly less. The changes will continue to be dramatic; libraries are less likely to be repositories of physical books, journals and other tangible items, and more likely to be the access portal to an increasing array of on-line information. Though, for the foreseeable future, the role of the library in education is likely to be a hybrid of the physical and the electronic:

> *…a stepping-stone between the traditional physical library and the purely digital.* [25].

While on-line books are still a rarity, on-line journals are now commonplace, with many libraries discontinuing hardcopy subscription of serial titles in favour of on-line versions, either directly from the journal publisher, or via content providers who consolidate on-line serial content from a large array of sources. In this situation the role of the library changes from being the repository of the journal, to being the portal that provides an on-line access path so that the user is recognised as a valid user by the commercial content provider, and, of course, being the budget centre responsible for funding the access to the on-line journals.

In the near-term, libraries will face a number of issues as they are transformed by the Internet, these include:

- funding the infrastructure, staff development and content subscriptions necessary to deliver on-line access to academic information;
- ensuring that students and other users have the information literacy skills required to effectively use the valuable information resources they will be offered by the library; and
- navigating the largely uncharted developments in Internet and on-line related copyright.

An innovative development in this area in Australian engineering education is the Australian Virtual Engineering Library (AVEL). AVEL is hosted by the University of Queensland, and is supported by a wide range of contributors with an interest in engineering education including the Universities of Melbourne and New South Wales, Monash

University, Queensland University of Technology, the Institution of Engineers, Australia (IEAust), the Distributed Systems Technology Centre, and the Centre for Mining Technology and Equipment [26]. AVEL provides a portal to engineering resources including web sites, conference announcements, jobs and employment, industry news, company web pages, the Australian Digital Theses Program and full text papers.

OTHER STRATEGIC ISSUES

Many view that IT is now an important enabler (if not the main driver) of change in education. If this is the case, then it is no longer possible or sensible to ignore IT issues in institutional strategic planning [27]. A US survey reports that 65.8 percent of higher education institutions have a strategic plan for IT; however, further investigation reveals that most lack substance, particularly when it comes to use of IT in education and financing IT [28]. Action / implementation without a detailed plan is like trying to build a house without a plan; yet it appears that it is still common for on-line / IT-based initiatives in education to be disconnected from the formal strategic planning process. The strategic planning process should address all environmental factors of significance to the organisation, and it would be a blind education organisation that didn't count IT and on-line developments among the more significant of contemporary environmental factors. At best, ignoring IT in strategic planning will leave the organisation to react to developments in this area. At worst, it may mean that IT initiatives that are undertaken do not actively support organisational objectives, or are at cross-purposes to the organisational objectives, wasting time, money and other scarce resources.

One area where the Internet has had a large impact on society in general is the provision of 'e-services', and e-commerce in particular. Compared to commercial enterprises, the education sector has been slower in offering e-services to students [16]. Students are offered a wide array of on-line services and payment options from banks, phone companies and others; however, many students find that similar services are not yet available from their university or school. On-line access to payment of fees, purchase of textbooks, academic transcripts, course registration and other student services is still highly variable.

Global communications networks will provide an opportunity for increased access to education, and the market potential of this growing audience of students has not been lost on the private sector. Cunningham et al. (1998) in a report on the involvement of global media and communication networks in higher education provision across borders note that, while there is much hype regarding the involvement of global media networks in higher education, the reality appears to have a slightly different focus. Currently, commercial interests in higher education are focussed on the carriage of educational content produced by others. The largest corporate involvement in education is via the 'corporate university' model, which is based on the provision of training (as distinguished from education) to large corporations. Cunningham et al. (1998) see that growth in this area increasingly competing with higher education for corporate funding, and that:

> *Australia's higher education sector [must] recognise the segmentation of the market globally and develop strategies to compete successfully in the profitable lifelong learning market. [29, pxvii].*

Commercial education providers and their use of the Internet for competition in more mainstream education markets is further advanced in the US, where commercial providers offer accredited bachelor's degrees [30] and are able to lure qualified educators away from traditional public institutions with the offer of better salaries [31].

CONCLUSION

The Internet and related developments in on-line communications will continue to drive and transform teaching and learning. This paper has presented a number of the strategic issues for those involved in the planning, development and delivery of on-line education. Even a cursory analysis of these issues shows that many of them are interrelated; on-line libraries do not work without infrastructure and will have to address many copyright-related issues, and, the most appropriate content development model can only be determined once an institution has articulated its strategic policy directions. A systems perspective is required to effectively integrate the 'on-line' into on-line learning. The 'most important' issue(s) for a particular institution will depend on their existing infrastructure resources, staff knowledge, attitude and skills, and institutional policies for on-line delivery.

What does the future hold for on-line education? Many technologies have promised to revolutionise education – the postal service, books, radio, television and computers, but, education appears to have endured predominately in the same basic form, with some technology-facilitated adjuncts. As noted in the opening, the Internet is creating new educational possibilities and providing support for teaching and learning. A recent survey of Australian universities [32] revealed almost unanimous support for the idea that the future of on-line education will mainly be a hybrid one – with on-line components combined with the option of face-to-face learning. While this survey was conducted in the context of postgraduate study, it suggests that, for the foreseeable future, on-line technologies will support conventional modes of education and offer new channels of mediation for off-campus delivery, rather than replace teaching and learning as we currently know it. As also noted previously, the passage of time and the advancement of technology are likely to both solve current problems, and provide us with new issues to consider.

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Biographical Note

Stuart graduated in electronics engineering, and worked in private industry for eight years with a consulting engineering firm. Working in electronic design, industrial automation and process control, he progressed from project engineer to senior engineer to business unit manager. In that time he also completed a Master of Business Administration in Technology Management.

In 1995 Stuart joined the School of Engineering and Technology at Deakin University, where he holds the position of senior lecturer, lecturing in Technology Management at undergraduate and postgraduate levels. Stuart has recently completed Doctoral studies in the area of engineering management education, and his research interests include engineering education, the use of new media in education and the relationship between technology and society. Stuart is a member of the Institution of Engineers, Australia, a member of the Australasian Association for Engineering Education, and a Chartered Professional Engineer