Towards a Global Sustainability Knowledge Network

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***Abstract**: Sustainability is central to engineering practice in the 21st century and therefore an essential element of engineering education. For practitioners, researchers and students relevant information on sustainability is dispersed or difficult to locate as it is generated by experts in many discipline areas not just in the traditional engineering ones. Sustainability is multi-disciplinary in nature. To meet these needs a web portal, the Sustainability Knowledge Network (SKN), has been launched, building upon the foundation of the successful Australasian Virtual Engineering Library. The SKN contains over 4000 resources and has other value adding services for its users, and these are being further developed. This network is pioneering a much of broader vision – the global Virtual Environment and Sustainable Systems Engineering Library (VESSEL). AVEL and AVEL-SKN were developed by a national consortium of partner organisations including universities, research organisations and engineering institutions, that were geographically dispersed. The successful development of these resources involved the close collaboration of engineers and librarians working as a distributed virtual team.*

***Keywords**: Sustainability, innovation, subject gateways, portals,*

Introduction

The issue of sustainability is moving from the fringe to the mainstream of engineering. This shift is driven a number of factors including impending regulations, a growing awareness in industry of concepts like the triple bottom line and espoused policies of professional engineering institutions globally (e.g. Ellis, 1994; IE Aust., 2003). Engineered products, systems and infrastructure must be sustainable in both the ecological and the social sense. It is no longer sufficient to build a technically sound, cost effective system delivered on time. On the contrary, it makes good business sense to develop innovative, sustainable systems, based on emerging technologies and which incorporate ecological and societal factors.

There is a global demand for high quality information on engineering and the technological aspects of sustainable development, especially via the WWW. However, the relevant information sources are dispersed across many discipline areas and are not easy to locate and assemble. Potential users are not always aware of what networked information is available. They are sometimes confused about various resources and have difficulty in finding relevant

resources. The sheer volume of information on the web is staggering. In 2002, the number of Web pages exceeded the number of people available to read them. In January 2003, Google invited Web surfers to search over 3.1 billion Web pages, while NetNames gave a figure of over 36 billion for total domains registered worldwide in the previous year.

The Sustainability Knowledge Network builds upon the earlier the Australasian Virtual Engineering Library (AVEL) to provide web-resource to assist researchers, practitioners and other professionals working in the areas of sustainability and engineering to share information and ideas on sustainability. Researchers use the Web not only to find information but also to "to maintain their identity, to engage in discussion and to circulate information" (Ballantyne and Addison, 2000). This paper outlines the development and future direction of AVEL-SKN and its emergent role as part of a proposed global network of resources in sustainability aimed at current and future engineers.

Evolution of AVEL

The Australasian Virtual Engineering Library (AVEL) was established in 1999 as part of a wider movement in Australia to develop discipline -specific, subject gateways in order to assist with the delivery and dissemination of academic information.

AVEL was designed as a gateway to quality web resources. This is achieved by having experts select resources for inclusion and by maintaining the information management disciplines of librarians, including the use of widely available thesaurus for terms, clearly developed and articulated resource selection criteria and consistency in the quality of record creation. The AVEL database contains records describing WWW resources selected for their relevance. This information is called metadata and includes both a summary of the resource, created by a librarian, and information pertaining to the location, creation and so forth for the original resource. By searching or browsing the AVEL metadata, a user can either link to that resource or extract relevant metadata. Links are regularly checked and information is updated. AVEL does not contain sources found only by trawling the WWW with an automatic robot, as is the case in other repositories. However, the quality assurance through the involvement of people in creating and maintaining the database is resource intensive.

AVEL- Sustainable Development

During 2000, the concept of a gateway focused on Sustainable Development for engineers was proposed. To avoid deflecting the core mission of AVEL, or trying to create a whole new gateway, a strategy emerged to establish AVEL-SD (AVEL-Sustainable Development) as a sub-site within the overall AVEL gateway. This allowed some sharing of resources without compromising the original AVEL. It was to be a prototype to explore a number of issues.

The AVEL-SD consortium was based on the original partner organisations with additional inputs from several of these especially the Institution of Engineers, Australia (IE Aust), the University of Queensland Library and the Distributed Systems Technology Centre (DSTC). Working closely with the IE Aust., the Institute of Professional Engineers, New Zealand (IPENZ) joined the consortium and both provided links to the World Federation of Engineering Organisations (WFEO) and United Nations Educational, Scientific and Cultural Organisation (UNESCO). Having both the peak professional bodies for engineering in Australia and NZ involved was indicative of the increased recognition of sustainable development and sustainability issues to professional practice. AVEL-SD was launched in November, 2001.

A basic business plan was developed to cover issues such as collection development and resource selection were resolved including access to materials from IE Aust and IPENZ from their environmental engineering and sustainability groups. While the trial was successful and considerable interest was raised, it was difficult to sustain both AVEL and AVEL-SD. During 2002 the Australasian Virtual Engineering Library decided to re-focus its content, redesign the user interface and strategically re-align itself to be more in keeping with this move towards incorporating sustainability principles into mainstream engineering practice.

Sustainable Knowledge Network

The Sustainability Knowledge Network, was envisaged as something more than a subject gateway or portal - a virtual place for engineers and others to "meet" and share information in many forms and media. The scope is not solely on sustainability, but the network also incorporates information on developments in core engineering disciplines (mechanical, civil, etc.), and developments in new technologies and innovations (but not just IT). This clearly reflects the AVEL origins. It has the benefit of not isolating sustainability as something new or different, but rather as part of the emerging spectrum of engineering.

The initial stage of the redevelopment involved the creation of a new web site hosted at the old AVEL domain name, as well as the migration of existing key resources already contained within the AVEL repository and the addition of new resources that focus on sustainability. In response to customer feedback the emphasis is on building a collection of freely available and reliable full-text content. Full-text papers from the Environmental Engineers Society (IEAust), CSIRO and the Academy of Science Technology and Engineering have been made available to AVEL for hosting.

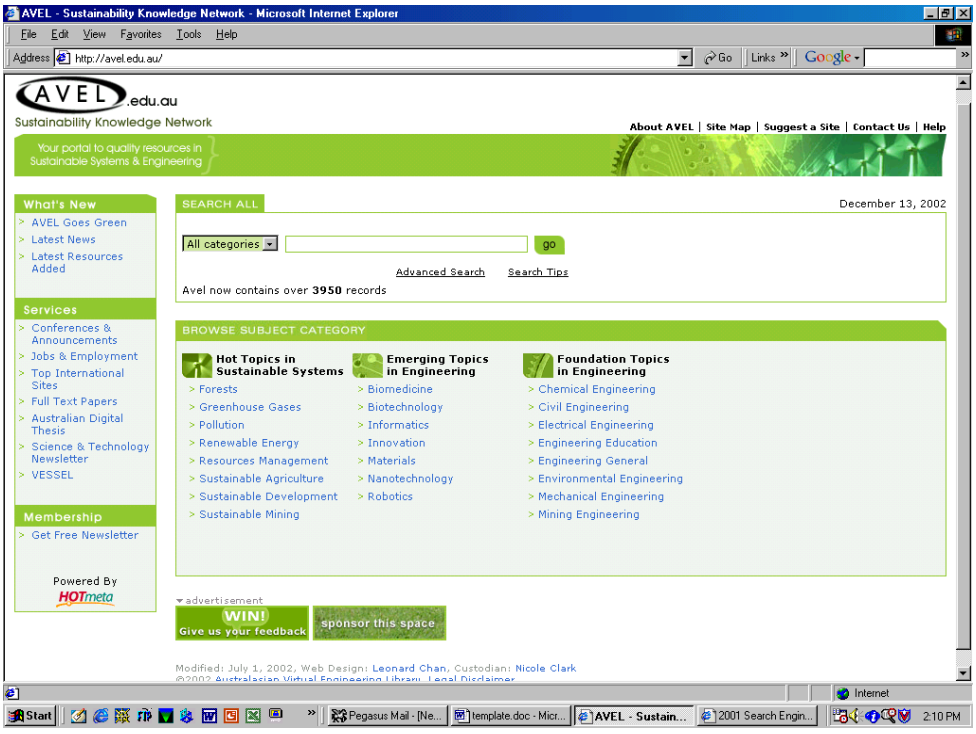

Figure 1: Sustainability Knowledge Network (avel.edu.au)

For the purposes of browsing the resources are organised into overlapping themes on the home page - Foundation Topics in Engineering, Emerging Topics in Engineering and Hot Topics in Sustainable Systems. The Foundation Topics are grouped by traditional discipline

areas, i.e. chemical engineering, civil engineering and so on. The Emerging Topics include biomedicine, biotechnology, informatics, innovation, materials, nanotechnology and robotics. The Sustainable Systems section is very broad and includes forests, greenhouse gases, pollution, renewable energy, resources management, sustainable agriculture, sustainable development and sustainable mining. The existing metadata management software (HotMeta from DSTC) was upgraded and the Sustainability Knowledge Network went live in September 2002. By the end of 2002, there had been a 17% increase in traffic to the domain, and a 75% increase over the previous 12 months.

The second phase of the redevelopment which is underway will see the trial installation of metadata harvesting software. If successful this will allow the Sustainability Knowledge Network collection to be rapidly expanded. The vision is to give the user the option of choosing either records evaluated by people or automatically harvested records or both. Project partners will also have the opportunity to use HotMeta 2.0 software to directly enter metadata which adheres to the project's metadata schema into their existing web page. This will enable more accurate harvesting to occur as well as save partners time in creating separate metadata descriptions. Increasingly, subject gateways are realising that hand-created metadata is an expensive process that cannot be supported on a stand-alone basis. A metadata record for an average website can take between 20 and 30 minutes to create. While these records add value to assisting resource discovery, they must be supplemented with viable, longer-term solutions.

The third phase will enable services which promote collaboration and knowledge exchange to be added to the gateway. The types of services and functions offered by the Sustainable Knowledge Network include:

Feature	**Purpose**
Searchable database with access to full text publications	• *Access to full-text publications such as technical reports and conference papers from partners* • *Intellectual Property rights for each document captured in metadata schema*
Expertise Directory	• *A searchable and browseable online directory to facilitate multi-disciplinary knowledge transfer and partnerships*
Topic based discussion forums	• *Regular moderated discussion forums which will showcase research*
Searchable, browseable, metadata enabled links	• *Central repository of metadata enhanced WWW resources*
Conference / Events Listings	• *Centralised discovery of conferences and events as well as user-submitted events listings*
Online News	• *Links to current news in the area of sustainability*
Bulletin Board for News Postings	• *Topic-based bulletin board postings to facilitate communication and knowledge sharing*

Table 1: AVEL-SKN Features

Thus the Sustainability Knowledge Network is becoming a web space that will allow users to interact, exchange information and collaborate using a broker model. But it is also part of an ambitious global project to provide web resources on sustainability and other services to practitioners, researcher and students everywhere.

Business Model

The basic business model we are adopting has five complementary parts: (1) raise revenue via tiered member scheme based on a value proposition made to the prospective members, (2) capture new content from members and other partners as in-kind contributions, (3) conduct consultancy or project work that both contributes revenue and either additional resources or some form of technical capability of value to the Sustainability Knowledge Network, (4) sponsorship of the site via advertisements on the home page and (5) grant income on an opportunity basis.

Four grades of membership are proposed – Platinum, Gold and Silver plus Foundation members. The subscription level for each grade of membership will be staggered and the benefits and services to each grade will also be tailored accordingly. These benefits can include membership the Advisory Committee, having logos included on home page and other publicity material, free MetaEdit software, unlimited record creation (available for Events Directory, AVEL-SKN database, Expertise Directory), awareness of new projects and websites which are relevant to sustainability are publicized through a web-based newsletter and "What's New" section and discounts on web page advertisements.

The primary in-kind contribution will be new content in the form of new resource suggestions but preferably metadata. It is expected that this will be a condition of membership in the higher categories. As an incentive, members can go to a higher grade based on a combination of annual subscription and a minimum number of new resources contributed over a 12-month period. (This is a form of loyalty scheme – like frequent flyers). The goal is to have members enter their own metadata as a strategy for making the continued growth of AVEL-SKN.

Consultancies and tenders provide a source of revenue but at the cost of diverting resources from core Sustainability Knowledge Network activities. Equally they provide an opportunity to add to core Sustainability Knowledge Network capabilities. Therefore the team will take on consultancies that are either of (a) strategic importance to the project and/or (b) add a key technology, other capabilities or content to the team that will directly benefit the ongoing development of the Sustainability Knowledge Network.

Advertising from sponsors on the Sustainability Knowledge Network home page is another way of raising revenue. Only advertisements that are broadly in keeping with the vision and goals of the project will be accepted. Acceptance of potential sponsors is at the discretion of the project's Management Team.

In addition, the Sustainability Knowledge Network team is seeking grant income on an opportunity basis. These will include small to medium grants for specific sub-projects that form part of the overall the Sustainability Knowledge Network as opposed to a single large grant for the whole service. The opportunities for gaining a single large grant for the Sustainability Knowledge Network are very limited due to changes in funding priorities. Its ongoing development is therefore dependant on the generation of new sources of revenue.

VESSEL – A Global Sustainability Resource

The Sustainability Knowledge Network is the inaugural part of a global set of resources in sustainability related to engineering VESSEL or the Virtual Environment and Sustainable

Systems in Engineering Library (Rourke, 2002). VESSEL is a joint project between the Sustainability Knowledge Network and the World Federation of Engineering (WFEO). WFEO represents the world-wide engineering profession through over 80 national members, and nine international members representing regional groupings. In partnership with UATI it forms the International Council for Engineering and Technology (ICET), an umbrella organisation associated with UNESCO.

The principal emphasis of the VESSEL network will be to provide developing nations with improved access to resources that can assist in education in science, technology and engineering, at senior levels in schools and technical colleges and universities. The network will aim particularly to provide resources to teachers and lecturers, and will seek to meet the requirements identified within the developing countries.

Each of the member nations of the World Federation of Engineering Organizations (WFEO) and of the International Union of Technical Associations (UATI), will be asked to become a supplier of material, or a user and definer of needs. The world-wide network they establish will be a substantial aid to international sustainable development. The Sustainability Knowledge Network is working with a number of agencies including the Institution of Engineers Australia, the Institution of Professional Engineers, New Zealand and other members of WFEO to build up resources and to undertake a series of projects that will incrementally further the development of VESSEL.

Discussion

AVEL-SKN is a significant and growing learning resource for engineering education in Australia, NZ and beyond. Potential users include prospective engineering students while still in high school (and their teachers), undergraduates, graduate students, course-work Masters and other graduates undertaking continuing professional development. To assist these user groups and add value to the site, we are developing a series of guidelines, fact-sheets and the like that provide a overview of key concepts and directions in sustainability in relation to current or emerging engineering practice. These will be available on the home page of AVEL as stand alone information but also encourage use of the core information in the AVEL-SKN database. The initial focus is on “green design” principles. This theme will cover such issues as general principles including definitions and concepts like triple-bottom line as well as information on design of the environment, by-product synergy and life cycle analysis.

Taking this one stage further, there is the opportunity to use AVEL-SKN as a hub for national, student-led initiatives in engineering and sustainability. AVEL-SKN was never intended as a passive virtual library, but rather as an active site that encourages people to work together to both contribute to its development as well as draw knowledge from it. Such an initiative would ideally involve not just engineering students (and researchers and practitioners) but also students from other disciplines in concerned with the environment and social issues. The AVEL-SKN team offers this challenges to the AaeE community and its wider constituents.

Further, AVEL-SKN, through VESSEL, offers opportunities for international educational outreach and collaboration. In particular, the Sustainability Knowledge Network is in a position to foster new and closer links between different disciplines, working internationally and coming from quite different perspectives and with diverse information needs. It is no

longer targeting a well-defined community of practice that has a common set of understandings and approaches as it did when it was the Australasian Virtual Engineering Library.

On a more pragmatic matter, gateways like the Sustainability Knowledge Network continue to provide a valuable service to a distributed, "invisible" constituency and user base, but they face a number of challenges from the next generation of Internet search engines (e.g. Google) and from the need to secure funds for continuing development and ongoing operation. These challenges present opportunities to create innovative ways to add additional value to their clients. Developments in web technology such as the OAI initiative (Hussein and Fox, 2001) increased emphasis on the development of web services architectures, changing web usage patterns and possible new models of the ownership and distribution of information in electronic form also offer opportunities for traditional gateways to morph into brokers, service providers and participatory networks rather than being simply repositories of quality information.

In addition to continuing to grow the resources base and extend value adding services to our clients through initiatives like VESSEL, there are a number of issues around how engineers and others use SKN that we plan to investigate. As engineers seem to rely upon "trusted" sources - like colleagues and tested information sources and informal networks, our aim is to provide a virtual equivalent of these trusted sources (Ellis and Haugan, 1997). Future developments will reflect this through the introduction and testing of interactive information exchange from users (similar to bulletin boards), access to expertise directories and the like. We are planning to conduct additional usability testing using an instrumented usability lab, to extend our earlier heuristic evaluation of user issues.

Conclusions

The Sustainability Knowledge Network is a new resource for engineering education at many levels – from high school to CPD. As the initial implementation of a global network, VESSEL, it has the potential to facilitate growing interaction between engineers and others around the topic of sustainability both in Australia and NZ and in our region. While it takes advantage of resources built up for the Australian Virtual Engineering Library, the future success of the SKN will depend upon the degree to which it is used, the quality and diversity of the new resources and value added features that are added and the willingness of groups to be financial and in-kind partners in it. AVEL-SKN is moving into new, largely uncharted, territory.

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