Sustainability Knowledge Network

David F.Radcliffe and Nicole Clark

University of Queensland, Australia

Abstract

Sustainability is a critical issue across many industry sectors in Australia. Research activity in sustainable development and sustainable technology is being undertaken in many disciples in the physical, social and life sciences. Currently, there is limited communication between researchers working on aspects of sustainability across different disciplines or different industry sectors.

In response, a Sustainability Knowledge Network (SKN) has been developed and launched that will bring together researchers, policy makers and practitioners working across the diverse and fragmented field of sustainability. The objective is to catalyse collaboration and technical innovation in this field. The gateway is available at: http://avel.edu.au.

The Sustainability Knowledge Network is built off the very successful AVEL (Australian Virtual Engineering Library). Thus it benefits from an established partnership that is growing to include a number of universities and Cooperative Research Centres as well as government and non-government organisations.

Introduction

The Sustainability Knowledge Network (or AVEL-SKN) is a new Australian Web-based initiative whose aim is to assist researchers, practitioners and other professionals working in the areas of sustainability and engineering. It is a collaborative project, lead by the University of Queensland. The Sustainability Knowledge Network and its previous incarnation, The Australasian Virtual Engineering Library (AVEL), is part of a wider movement in Australia which has focused on developing discipline -specific, subject gateways in order to assist with the delivery and dissemination of academic information. In Australia, this movement is coordinated by the Australian Subject Gateways Forum. Subject gateways grew out of initiatives undertaken in the United Kingdom, such as the eLib program.[1]

Subject gateways perform an important role as a "middle-ware" agent. They sit between the user and the Web, helping the user discover relevant resources and delivering them in a usable format. The fundamental strength of gateways lies in human expertise and judgment in the selection of resources and the manual creation of metadata records. In essence they assist the information seeker to make sense of and to navigate an increasingly vast and dispersed array of information resources.

As an information source the Web is at once exciting and daunting. Although it is a truism to say that the size of the Web is proving increasingly problematic for information seekers, it is still sobering to remember the estimated dimensions of this colossal information source. In 2002, the number of Web pages exceeded the number of people available to read them.[2] In January 2003, Google invited Web surfers to search over 3.1 billion Web pages, while NetNames[3] gave a figure of over 36 billion for total domains registered worldwide in the previous year.

An earlier study at the University of California, Berkeley differentiated between the "surface" Web and the "deep" Web. The "surface" Web consists of approximately 2.5 billion documents. However, taking into account *all* web-accessible information including specialised web-connected databases and dynamic Web sites (collectively known as the "deep" Web), there are over 550 billion web-connected documents, of which 95% are publicly accessible. These sites are not widely known among average surfers, even though the information available is 400 to 550 times larger than the information on the "surface" [4]. In addition, 7.3 million pages are added every day to the total Web.

Subject Gateways: Evolution and Adaptation

The first generations of subject gateways were an evolutionary or adaptive response to what was perceived in the mid 1990's as the growing dysfunction or anarchy of the Web. One commentator writing at the time termed the Web a "chaotic repository for the collective output of the world's digital printing presses." [5]

Subject gateways were an obvious solution to this information explosion. The term "subject gateway" has been defined as " a Web-based mechanism for accessing a collection of high quality, evaluated resources identified to support research in a particular subject discipline." [6] Using standard metadata schemas to describe Internet resources and the services of subject or information specialists to evaluate information provided a new form of quality control. Experts added value to Internet resources by discovering them, describing them and making them searchable and browseable.

While the basic premise for the development of subject gateways remains relevant today, the model on which they operate is changing. Business models, technological infrastructure and service delivery options are all being revised. It is fair to say that there is no longer "one" model operation but rather a variety of often intersecting models. In Australia gateways such as the Australian Literature Gateway (AustLit) provide free and subscription level services. Others such as Edna Online (an education portal) have entered into memorandums of understanding with partner gateways in order to harvest or exchange metadata. The National Resource Discovery Service, being developed by the National Library of Australia, is a project looking at how the Open Archives Initiative protocol might help achieve interoperability between gateways. The Sustainability Knowledge Network is also in the process of examining how metadata harvesting and automated metadata entry by partners directly into their html pages can simplify record creation.

There are a number of reasons why these changes are occurring. The first is sustainability. Gateways in Australia have been typically established with non-recurrent federal government grants. Funding levels are modest by international standards. Many Australian gateways have business models in place but by commercial standards their revenue stream is small. Gateways are increasingly looking at ways that they can collaborate with each other, with industry and other key stakeholders in order to ensure their longevity.[7]

The second reason is technological change and the changing environment in which we operate. When gateways were first established in the mid to late1990's, search engines were fairly unsophisticated. The next generation of search engines such as Google and All The Web go beyond indexing only HTML pages and can recover more of the "deep Web" (such as PDF and image files) than was previously accessible. Their search algorithms also mean that more relevant search results are returned.

In order to retain their role as a vital human intermediary, gateways have had to adapt and refine the services they offer. Gateways have evolved in order to save their users searching time and to deliver them the content and services that they require. In the case of the Sustainability Knowledge Network, one way to ensure this is to provide more evaluated, full-text content. The "deep Web" remains a very real obstacle to researchers accessing the high quality information, despite inroads made by search engines. In an online user survey conducted by AVEL in 2001 72% of respondents said that finding full-text resources was important to them. By "surfacing" these resources gateways provide a significant value-added service to their users. Facilitating collaboration and knowledge exchange between members of their user community is another way that gateways are distinguishing themselves from other Web search tools and this will be discussed more below.

The third and possibly the most pressing driver of change for subject gateways is their user group. Research has suggested that the gateway concept alone will not satisfy the demands of savvy researchers in the future. The results of focus groups and an online survey conducted by AVEL echo what has long been established in the literature about the information seeking habits of those working in engineering, science and technology. Researchers use the Web not only to find information but also to "to maintain their identity, to engage in discussion and to circulate information".[8]

One of the major challenges for information providers at the moment is providing integrated access to this growing range of distributed and heterogeneous information resources and services. Exciting work is being done in Europe and the United Kingdom around the development of broker or "middle-ware" architectures.[9] The Renardus project is one such initiative.[10] Such technology is, however, expensive and AVEL is exploring more cost effective alternatives and partnership opportunities that may facilitate this type of cross-sector information exchange.

Sustainability Knowledge Network: Small Steps - Big Vision

In August 2002 the Australasian Virtual Engineering Library decided to refocus its content, redesign the user interface and strategically realign itself to be more in keeping with this move towards incorporating sustainability principles into mainstream engineering practice. This was a

logical step as AVEL already contained a significant number of resources concerning sustainability. Also, the Engineering profession is increasingly recognising that sustainable development and sustainability issues are central to their professional practice. The peak professional body in Australia, the Institution of Engineers, Australia (IEAust) has included an awareness of the principles of sustainable development as one of the core attributes that graduates must possess.

Sustainability is used in the sense of the triple bottom line, that is financial (including technical) sustainability, ecological sustainability and social sustainability. Engineers are increasingly realising that the he products of engineering must not only be technically sound and cost effective, they must also be sustainable in both the ecological and social dimensions. This demands innovative solutions built on solid engineering foundations, systemically drawing on emerging technologies and incorporating ecological and societal considerations.

The AVEL / Sustainability Knowledge Network team have taken a pragmatic approach in undertaking the redevelopment of the Web site. A number of key stages have been identified and incremental changes made accordingly. These stages range from the easily implemented, to the more ambitious or costly.

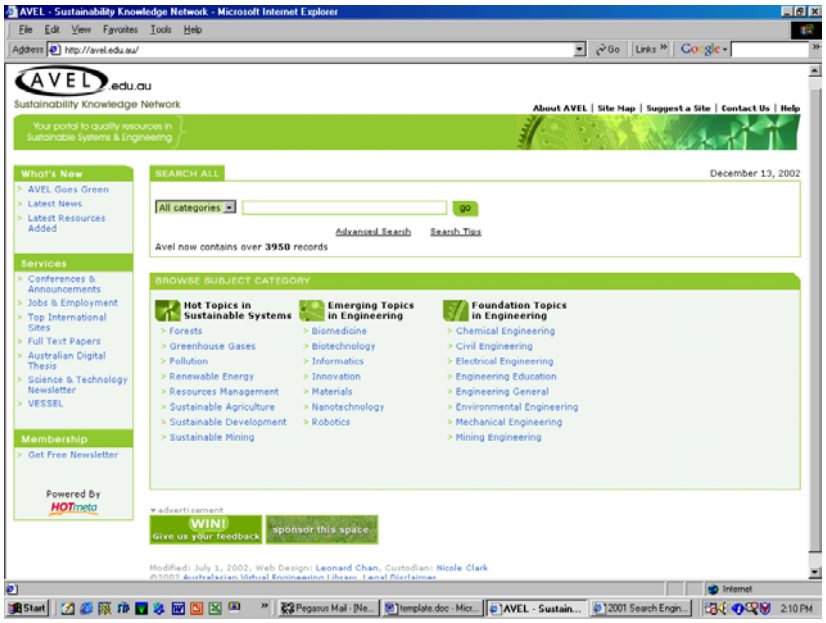

Figure 1: Sustainability Knowledge Network Homepage (December 2002)

The initial stage of the redevelopment has seen the development 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 that suggests that users come to sites like AVEL to find freely available and reliable full-text content, increased emphasis has be given to building the collection in this area. 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. The existing metadata management software (HotMeta from DSTC) was upgraded during this time. The Sustainability Knowledge Network went live in September 2002. Since that time there has been a substantial increase in traffic to the domain.

The second phase of the Website redevelopment, is planned for early 2003 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 only humanly evaluated records or automatically harvested records. 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 are of great value in 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:

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*
An 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 Australian 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* • *Promotes Australian intellectual capital*
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*

For the user community of the Sustainability Knowledge Network, that is researchers, practitioners and students working in the inter-related but dispersed areas of engineering and sustainability, ultimately what is needed is a Web space that will allow them to interact, exchange information and collaborate. Thus the SKN will act as a "broker" that connects users with distributed content and users directly with other providers and sources of expertise.

Pioneering a Global Resource

The Sustainability Knowledge Network is the inaugural member of VESSEL - the Virtual Environment and Sustainable Systems in Engineering Library. VESSEL is a joint project between the Sustainability Knowledge Network and the World Federation of Engineering (WFEO). 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.

Funding Dilemmas

The Sustainability Knowledge Network team will continue to seek grants 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 of government research agencies. Its ongoing development is therefore dependant on the generation of new sources of revenue.

The basic business model we are adopting has four 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 and (4) sponsorship of the site via advertisements on the home page.

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 include membership of 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 the Sustainability Knowledge Network sustainable.

Consultancies provide a source of revenue and an opportunity to add to core Sustainability Knowledge Network capabilities but at the cost of diverting resources from core activities. 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. An appropriate fee structure will be determined in early 2003.

Concluding Remarks

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,[11] increased emphasis on the development of Web services architectures,[12] 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 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. As the lead player in the global VESSEL project and as it extends the number, type and diversity of its members and collaborators, it is moving into new, largely uncharted, territory.

Acknowledgements

The authors would like to thank the many people who have contributed to the development of AVEL and the Sustainability Knowledge Network. The financial support of the Australian Research Council and the financial and generous in-kind support of our foundation partners is acknowledged. The foundation partners are: The University of Queensland, Queensland University of Technology, Melbourne University, Monash University, the University of New South Wales, and the Institution of Engineers, Australia.

Bibliography

1. Law, Derek and Lorcan Dempsey (2000), "A policy context - eLib and the emergence of the subject gateways." *Ariadne*, 25, [Online] Available at: http://www.ariadne.ac.uk/ Accessed 14/3/03
2. DigitalDesign Works 2001, *Web sites: number of pages*, [Online] Available at: http://www.ddwinc.com/docs/pages.html Accessed 14/3/03
3. NetNames 2001 *Domainstats.com: your complete domain names resource*, [Online] Available at: http://www.domainstats.com/ Accessed 14/3/03
4. Lyman, P. and Varian, H.R. 2000 *How Much Information*, University of California at Berkeley, [Online] Available at http://www.sims.berkeley.edu/how-much-info Accessed 14/3/03
5. Lynch, C., "Searching the Internet", *Scientific American*, 276 (3), .52 (1997).
6. National Library of Australia 2001, *Definitions of web-based services*, [Online] Available at: http://www.nla.gov.au/initiatives/sg/servicetypes.html Accessed 14/3/03
7. Campbell, Debbie L. (2000), "Australian subject gateways: political and strategic issues," Online Information Review, 24 (1), 73-7.
8. Ballantyne, P. and Addison, C., "Cooperation on the Web: trends and practice in the development sector", *Information Development, 1*6 (1), 15 – 23 (2000).
9. Huxley, Lesley (2001), "Renardus: fostering collaboration between academic subject gateways in Europe," *Online Information Review*, 25 (2), 121-7.
10. Renardus 2002, Renardus Homepage, [Online] Available at: http://renardus.lub.lu.se/ Accessed 14/3/03
11. Suleman, Hussein and Edward A. Fox (2001), "The Open Archives Initiative: realizing simple and effective digital library interoperability*," Journal of Library Administration*, 35 (1/2), 125-45.
12. Gardner, Tracy (2001), "An introduction to Web services," *Ariadne*, 29, [Online] Available at: http://www.ariadne.ac.uk/ Accessed 14/3/03

Biography

David Radcliffe
David Radcliffe is the Thiess Professor of Engineering education and Professional Development in the School of Engineering at the University of Queensland. His research draws on and involves collaboration with the social sciences especially anthropology. David is co-director of the Catalyst Centre and Director of Professional Development in the School. He was a National Teaching Fellow, in 1994 and a Boeing-A.D. Welliver Fellow, in 1999.

Nicole Clark
Nicole Clark is the coordinator of the Sustainability Knowledge Network and the Senior Librarian at the Dorothy Hill Physical Sciences and Engineering Library. She has coordinated a number of digitization and Web-based projects at the University of Queensland Library. Nicole is the recipient of the 2002 Margaret Waugh Bursary.