WWW Support for Materials Engineering Education

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I. Introduction

Students have become very familiar with the use of the Internet for communication and recreation. As a result, they are also becoming comfortable with the use of the Internet to carry out class-related assignments and research. With numerous Internet terminals scattered across most campuses, it is very easy for the students to get access to web resources – often much easier than it is for them to access conventional library resources. Students in introductory Materials Science classes at GVSU have, for several years, been asked to search the Internet for specific types of engineering design data. More recently, manufacturing students in a graduate level course on contemporary developments in materials have been asked to use the Internet to find information to supplement what was available in their course references.

Engineering programs throughout the country have been criticized for ineffective usage of computers in engineering education[1]. Use of the Internet for research on engineering materials is an effective application of computers to engineering design in a way that is quite different from the more conventional computational applications. Students can use the Internet to find design data, to communicate with the instructor and to collaborate with other students on their assignments. By being able to electronically link to remote engineering resources, students can broaden the scope of their knowledge beyond what is available at any particular campus. By tapping into the resources of companies, libraries, professional and trade organizations and universities worldwide, it is possible to get a much broader base of information than is available at any one location.

II. Examples of Web Based Resources

The number of web based resources applicable to materials science and engineering is growing at a very rapid rate. Sources of these resources include governmental agencies, universities, professional societies and corporations, as well as individuals interested in materials issues. Information available ranges from non-technical advertising to highly technical research reports and materials property and applications data. Web resources in materials engineering have become far too extensive to review comprehensively. The following, however, are examples of web sites with extensive materials information, or list of references to other materials related sites.

Governmental Sources -

Argonne National Laboratory	www.anl.gov
Department of Energy	www.doe.gov
FedWorld Information Network	www.fedworld.gov
National Institute of Standards & Technology	www.nist.gov
Sandia National Laboratories	www.sandia.gov

Academic Sources -

Drexel – Materials Engineering	www.materials.drexel.edu
MIT Materials Science and Engineering	www-dmse.mit.edu
National Pollution Prevention Center	www.umich.edu/~nppcpub
Queensland Mining, Minerals, and Materials –	mama.minmet.uq.oz.au/~simo
Introduction to Material Science (VRML)	n/work/index.htm
Visualization in Materials Science	vims.ncsu.edu

Organizational Sources -

The Aluminum Association	www.aluminum.org
SAMPE	www.sampe.org
American Iron and Steel Institute	www.steel.org
Australian Stainless Steel Development Assoc.	www.assda.asn.au
ASM International	www.asm-intl.org
The Copper Page	www.copper.org
The Institute of Materials	www.instmat.co.uk
The Materials Research Society	www.mrs.org
Metal Powder Industries Federation	www.mpif.org
Minerals, Metals & Materials Society	www.tms.org
Stainless Steel Information Center	www.ssina.com
International Titanium Association	www.titanium.org

Corporate Sources –

Allegheny Teledyne Wah Chang	www.twca.com
Allied Signal Plastics	www.asresin.com
Carpenter Technology Corporation	www.cartech.com
Ceramic Consulting Group	www.ceramics.com
GE Plastics	www.geplastics.com
Steelynx	www.mlc.lib.mi.us/~stewarca/steelynx.html

Trade Publications –

NASA Tech Briefs	www.nasatech.com
Pollution Engineering Magazine	www.pollutionengineering.com
Polymers DotCom	www.polymers.com
Research & Development	www.rdmag.com
Waste Age Publications	www.wasteage.com

Web Indexes on Materials Engineering –

Yahoo! Science: Engineering: Material Science	dir.yahoo.com/Science/Engineering/Material_Science/
The WWW Virtual Library: Engineering	arioch.gsfc.nasa.gov/wwwvl/engineering.html

Environmental and Recycling Information[2] *–*

Arizona Department of Environmental Quality	www.adeq.state.az.us
Environmental Industry Associations	www.envasns.org
Environmental Protection Agency	www.epa.gov
Michigan Department of Environmental Quality	www.deq.state.mi.us
Recycler's World	www.recycle.net

III. Student Applications of Web Based Resources:

Sophomore materials students select an engineering material or group of related materials to be researched using both conventional text resources and web resources. They are to obtain and document information on the engineering properties, processing and applications of the materials. The only restriction on their searches is that the Internet sources which they reference need to provide information that is freely available to anyone with web access and that does not require a payment or special access privileges. An annotated bibliography describing the resources that they have found is then submitted in both paper and hypertext forms.

An important part of this bibliography is an evaluation of the data available from each source, particularly web sources. They are first asked to evaluate the *usefulness* of the data in carrying out the design of an engineering product or process. They are then asked to evaluate the *quality* of the data with respect to the following criteria:

- Is there any obvious bias in the data presentation?
- Why is the web page sponsor providing this information freely? *(Any hidden agendas that need to be understood?)*

- What is the environmental impact of using these materials or process? *(In line with the Padnos School of Engineering's emphasis on environmentally responsible design - http://engineer.gvsu.edu/pse-info/mis_val.html)*

- Does the data appear to be technically accurate?

Graduate students were asked to do a similar research effort but with the topics dealing with recent developments in materials engineering that they might be able to apply to the product line at their place of employment. Since the materials to be researched were fairly new, the students had to rely on journal articles and web resources rather than texts or reference books in most cases.

IV. Problems with Web Based Resources

Although the Internet is a useful tool for materials study, there are still many problems that prevent it from being the only resource needed for engineering design. Students often complained that they were deluged with an overload of information as they performed their searches. A web search on a simple engineering material often led to many thousands or millions of hits. It became impossible to sort out those that were truly applicable to the material they were researching. Surprisingly, another strong response from the students was the lack of information available. Often this response came from the same students who had complained of an overload of information. Although there were lots of 'hits', it was often difficult to find any truly *useful* information.

As was observed in a previous Internet research assignment several years ago, the sophomore students also had a great deal of difficulty evaluating the quality of the data they found. Their evaluation of site content seemed to often be based on their perception of the site sponsor rather than the actual information content. Surprisingly, government and academic sponsored sites were perceived most favorably, while commercial sites (anyone having a product or service to sell) were perceived with a great deal of skepticism. Part of this skepticism concerning commercial sites may be related to the limited information provided at many of these sites. This limitation may be due to concerns about the compromise of proprietary data or to the potential for lawsuits due to the misuse of data.

The students also found that many of the sources of data that they perceived to be the best were not available without some form of payment. The effort to find some way to make access to information electronically a viable commercial exercise has led to restricted access at many sites. A small amount of information is often provided as an advertisement, but the user is required to pay through a subscription fee or a per use credit card charge in order to get detailed information about materials and processes.

Graduate students had considerably less difficulty with being inundated with data due to the very specific advanced materials topics they were researching. The sources found tended to be quite focused on the material they were studying. As would be expected, they also seemed to be better able to evaluate the content critically. This, however, may have more to do with the typical sources of advanced materials information more than the maturity of the students.

V. Conclusions

The non-linear nature of the hypertext data makes easy extensions and correlations of work that is being carried out. It is also possible to present data in ways that are not possible using text-books or video presentations. A web resource may contain audio and video clips reinforcing the textual content. There can also be interactive data presentations using tools such as Working Model, Mathcad or VRML. The usage of these visualization techniques can be especially helpful in promoting understanding of complex graphical relationships such as crystal structures, diffu-sion mechanisms or phase transformations.

Unfortunately, however, current web resources tend to provide incomplete views of technical topics. Information presented is generally not independently reviewed and references are often not provided or are incomplete. Except for some corporate and government sponsored work, complete technical documents are rarely provided on the web due to copyright concerns. The dynamic nature of the Internet also makes documents difficult to track since the document may change without notice, unlike a print publication.

In spite of these problems, most students who have used the World Wide Web to research mate-rials topics have been very successful. Research materials are plentiful, if incomplete, and rea-sonably easy to access with fast search engines and topic indexes. The students always seem to have difficulty, however, with the evaluation of web content. Since anyone can publish on the web without review, it is difficult to know what information is truly of value and what is inaccu-rate or misleading. Often what the students find is intended only to sell a product or to argue for a particular viewpoint rather than to provide objective technical data. Most of the students seem to have great difficulty evaluating the content or choosing between different views expressed on opposing web sites. Although this is probably just as true for print media, reviews subjected to most technical publications provides some control on the content.

The need to train students in analyzing web content seems to be becoming more important as students begin to rely more heavily on web resources. A few years ago, it was difficult to get many students to look at the Internet for their research resources. In the most recent exercise, however, the reverse was true. Web resources were used even when they were incomplete and possibly inaccurate, even when more complete journals and reference works were available.

Bibliography

1. Jones, J. B., "The Non-Use of Computers in Undergraduate Engineering Science Courses", *Journal of Engineer-ing Education*, January 1998, 11-14.
2. Johnson, P. D., “Internet Resources for Environmental Engineering Education”, presented as part of the Environ-mental Engineering Division program at the ASEE Annual Conference, June 18, 1997, Milwaukee, Wisconsin. Available on-line at http://mse.engineer.gvsu.edu/environment/Environment_Resources.html.

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