

Engineering Research Web Modules—Designing for Students' Needs

Cecilia P. Mullen, Sandra H. Kajiwarra
San Jose State University, San Jose, California 95192-0028

Introduction

Electronic storage and retrieval of information has forever changed the ways in which researchers conduct their investigations of the literature. The evolution of electronic storage has been dramatic and rapid. In just the past ten years information science has moved from online systems, to compact disc storage, to web based systems. Search and retrieval within these various systems have necessitated relearning databases each time they change format and/or searching protocol. This relearning has also been made more complex as databases proliferate and merge.

Effective researching methodologies are not intuitive and the researching skills that high school students bring with them as incoming freshmen (or that community college students bring with them as transfer students) cannot prepare them for the complexity of today's information retrieval. Students should not rely on chance to locate their supporting literature, and practicing engineers cannot afford to overlook any relevant documents germane to their research and design. Engineers must be able to systematically review their literature in a comprehensive and efficient fashion.

Background

Guides to the Literature have been created as tools to introduce graduate students and researchers to their literature and there are many examples of these in university libraries. Characteristically written by librarians, these guides are created for a specific field of study and follow a traditional method of listing and describing sources of information by type of material, e.g. dictionaries, handbooks, directories, and so on. For years, at the graduate and undergraduate level, we have taught engineering students about the various bibliographic resources important in their fields, and we have often relied on this same format to structure the classroom presentation, albeit in an abbreviated form. Generally, we have only been allocated one hour per semester of class time to identify and teach the use of major engineering resources. As technology has advanced, more publications and research tools have become available, but the one-hour lecture in the engineering class has remained the same. The result is that the students are significantly shortchanged in their introduction to the key tools for engineering information retrieval. Dissatisfied with these circumstances,

our solution to these deficiencies was to develop an alternate tool—an electronic roadmap to the engineering literature. We wanted to design a web site that was organized based on the informational questions posed by an engineering student, not on the structure favored by an academic library bibliographer. This would be a strategic departure from the traditional literature guides.

The demographics of our San Jose State University students were important factors in the creation of our electronic roadmaps. The average age of the SJSU engineering student is 26 years old. The university overall has a total of 57% undergraduates and graduates who are minorities. The College of Engineering has 72% who are minority, while the College of Social Sciences has just 46% undergraduates and graduates who are minorities.⁴ Although the information is not currently collected, teaching faculty in the College of Engineering estimate that more than 60% of the undergraduate engineers are already employed in some capacity in their field of study and that at least 85% of the graduate engineering students are so employed.

The College of Engineering has high unit majors, ranging from 130 to 136 credits required to graduate. While the engineering students must be proficient in their information seeking skills, the engineering faculty does not have the luxury of committing a significant amount of time to teaching these skills within their classroom instruction time. Although SJSU requires an upper division engineering writing class, its scope encompasses all engineering disciplines, making it an inadequate forum for addressing unique information retrieval techniques that are appropriate to individual fields of engineering. In providing lectures to these classes over the last twenty years, the engineering librarians have found that in sixty minutes it is impossible to effectively provide meaningful information retrieval instruction to majors in eight different engineering disciplines. Coincidentally the ineffectiveness of this is confirmed by Leckie & Fullerton (1999) in a recent major study on information literacy in science and engineering undergraduate education. They conclusively state, “that a library research instruction program will not succeed if it is kept generic.”²

There already existed an established record of cooperation between the engineering librarians and the various departments within the College of Engineering. Within this college the most extensive pattern of collaboration has always been with the departments of Chemical Engineering and Materials Engineering, which merged administratively five years ago. We determined that a formalized instructional program developed in cooperation with the Chemical and Materials Engineering faculty would be an appropriate stage to introduce and test the effectiveness of a new teaching strategy for information retrieval. This department is appropriate for several reasons. Both the fields of Chemical and Materials Engineering have a large body of published literature in which the engineers must be able to search effectively to support their research and design. The classes at SJSU in this combined department have consistently required the integration of comprehensive literature searches into their class projects. The current curriculum of the College of Engineering has been designed with extensive input from industry and guidance from ABET (Accreditation Board for Engineering and Technology). This curriculum reflects a strong component of critical thinking throughout the engineering classes. The program objectives of each department carry out this commitment.

Our Project

Rosenzweig and Gardner (1994) reported on their survey in *Chemical Engineering Progress* that, “chemical engineers today spend a considerable amount of time retrieving and using information on a wide variety of topics. . .” but, “depended on personal collections and other engineers for their information, and were not making good use of the growing number of electronic options. More than half the survey respondents attributed this to their inability to find and use appropriate information.”³ The electronic options have grown tremendously since Rosenzweig and Gardner cited their findings, but our experiences in the engineering classrooms have taught us that the students have not kept up with the changes. The students have discovered the Internet but do not use it in a sophisticated way. We wanted to remedy this lack of sophistication by easing students into the variety of engineering resources in an inviting way.

With an instructional grant from SJSU, we designed two instructional modules on a web site (<http://library.sjsu.edu/staff/kajiwara/info.html>) for Chemical Engineering and Materials Engineering. We partnered with a faculty member from each discipline to use two classes to test our web site. In Fall 2000 and Fall 2001, research papers completed for Materials Engineering 115 (Structure/Properties of Solids) were retained. In Spring 2001 research projects for Chemical Engineering 165 (Chemical Plant Design) were retained. As a first step in our assessment, we analyzed papers and project reports from both classes for the quality and quantity of the references which students used. Citations were reviewed for scholarly publications, for currency, and for their overall breadth in representing the project topic. This gave us a benchmark of the students' command of engineering resources before they were given access to our web site. As we analyzed the papers, we discovered that the students needed access to examples of technical report writing, and guidance on how to cite their references and how to create a complete bibliography.

Project Goals

The goals of our project were to: 1) significantly improve the students' knowledge of the literature of their discipline; 2) increase the breadth of the literature that they incorporate into their class projects; 3) develop an expertise in the students' capabilities to search the literature; 4) extend the students' critical thinking to include the ability to critically analyze a variety of print and electronic sources to determine their validity and reliability; 5) instill expert research techniques in the students which will serve them throughout their professional careers and in later life; 6) learn the basics of citing references, including citation elements and formats; and finally, 7) allow engineering librarians to have more time for individual student and faculty consultations on advanced research methods and techniques.

Leckie and Fullerton (1999), and Cannon (1994) in separate articles determined that science and engineering faculty prefer a self-directed learning mode for information literacy, both for themselves and for their students.^{2,1} By developing these web site modules, we are able to incorporate a substantial amount of instruction into the classes, without taking class time

from an already impacted schedule. Students can use these modules on their own time for research and review. The web site can be consulted throughout the process of completing their assignments. This format also has the advantage that students with a variety of learning styles can achieve a level of comprehension that is competitive with their fellow students. Students for whom English is a second language have the opportunity to spend as much time using the modules as they need for their level of language comprehension.

Project Design

Our electronic roadmap design started with three important parameters:

- 1) Make the web module attractive and inviting to use
- 2) Keep descriptive information to a minimum
- 3) Conform to the standards recommended by the Americans with Disabilities Act

We examined many web site literature guides, both for engineering and other subjects. The design for these web sites follows a pattern. Databases and other recommended resources are arranged by format under general subjects. Detailed descriptions are provided for each resource. Presented with pages of dense information to scroll through, it is assumed that the engineering student will absorb all of the descriptive information on a database or publication, make an informed choice on the correct resource to use, and know how to use it.

At San Jose State University, we wanted to break from this style but still provide students with the information they need. We made a conscious effort to minimize the amount of descriptive information presented to the students for each resource. Too many details about a resource seemed a deterrent to getting students to use the web modules, and ultimately the proper resources. In consultation with the participating faculty, we chose categories of information commonly needed by the engineering students in chemical engineering and materials engineering and used those categories as our framework. For Chemical Engineering we used the following categories: Chemicals; Equipment; Formulas, Properties, Data, etc.; Government Information; Patents; Process; Safety; Standards/Specifications; Research Project/Term Paper guidelines; and Professional Associations/Societies. (Appendix A shows the entire introductory page for the Chemical Engineering Module.)

Under each of these information categories we listed databases, websites, or paper resources that best supply information. We decided to provide a few major places where the student could reasonably expect to find information, rather than trying to list any and all possible sources. For example, under the category "Process", we listed the *Encyclopedia of Chemical Technology*, *Perry's Chemical Engineers' Handbook*, and *Ullmann's Encyclopedia of Industrial Chemistry* as places to look for their topics. We used hypertext links to connect students immediately with either the database or the online entry in our catalog for a paper source. Most of our hypertext links have little or no accompanying description. (The "Process" page is shown in Appendix B.)

Assessment

We initially decided to use two methods of assessment for the participating classes based on their differing types of term assignments. We decided to analyze the references cited at the ends of the papers for the Materials Engineering class, and to use a questionnaire for the Chemical Engineering class. In the Chemical Engineering class several students working together produce one project, so individual effort would be harder to track through analysis of the projects' references. We also decided to analyze the types of information sources (i.e., journals articles, books, conference papers, etc.) for both classes to see if the students had used a greater variety of resources in the post-module term papers and projects.

In Fall 2001 we gave a lecture to the Materials Engineering 115 class introducing them to the items in the Materials Engineering web module. When the Fall 2001 Materials engineering class ended and the papers were turned in, a comparison of the currency of the references were made between the pre-module papers, and the post-module papers. The effectiveness of the Materials Engineering module was assessed in consultation with our participating faculty. We examined the currency of citations used by the students and the variety of resources they had used. In Figure 1, the currency of references is charted for the pre-module class of Fall 2000, and in Figure 2 for the post-module class of Fall 2001. The difference in the dates of the references found and used by the students is striking. The post-module group found many more up-to-date references for their papers than the pre-module group. The total number of papers presented in each class differed by only one; Fall 2000 papers totaled 13 and Fall 2001 papers totaled 12.

Figure 1 (Pre-Module)

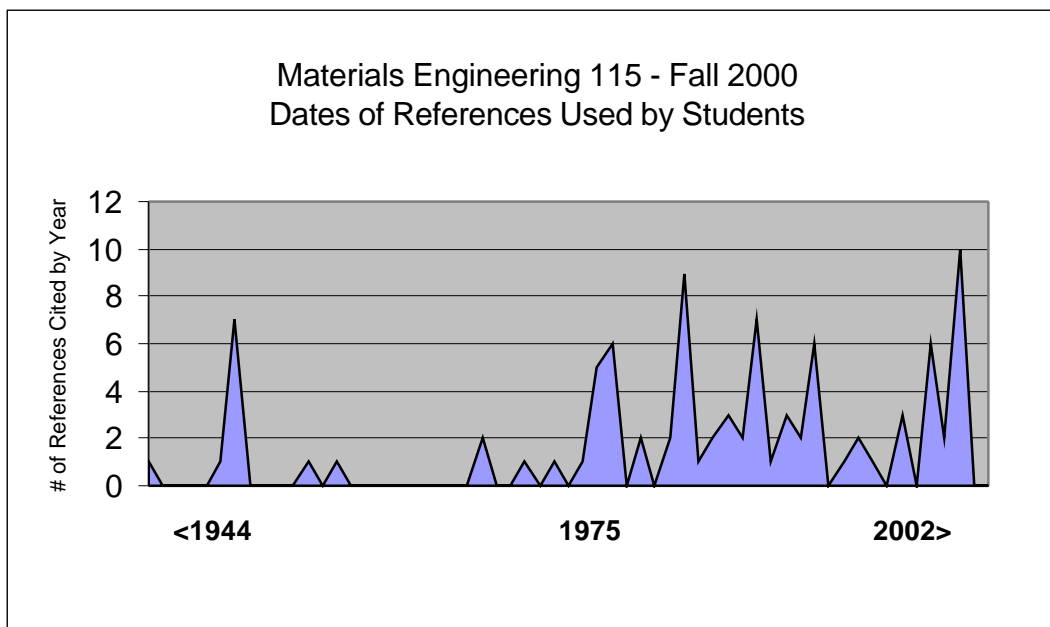
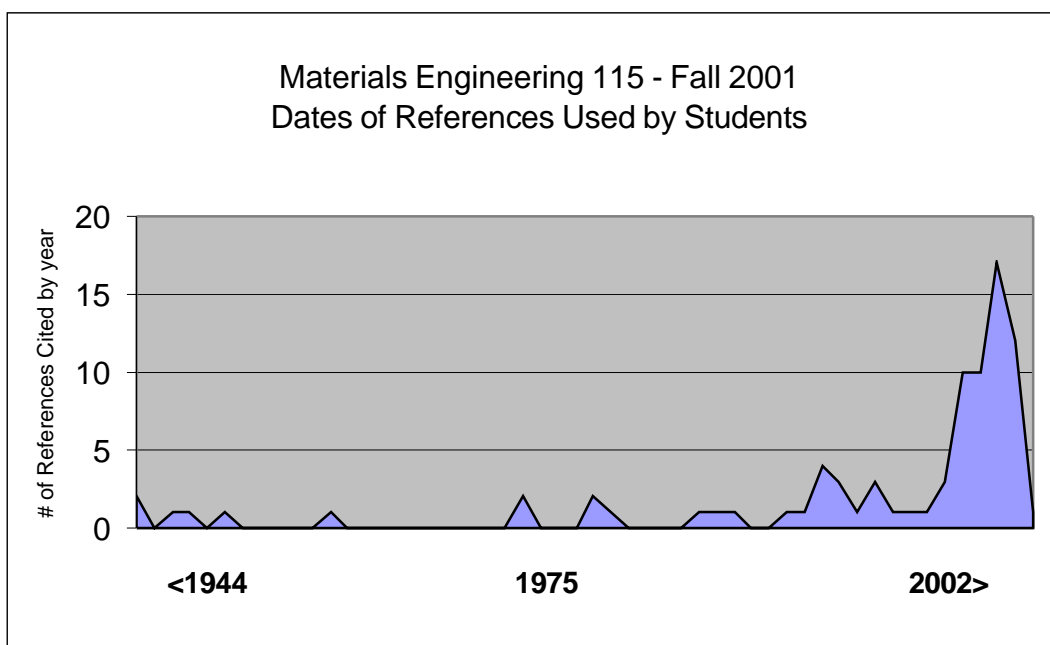


Figure 2 (Post-Module)

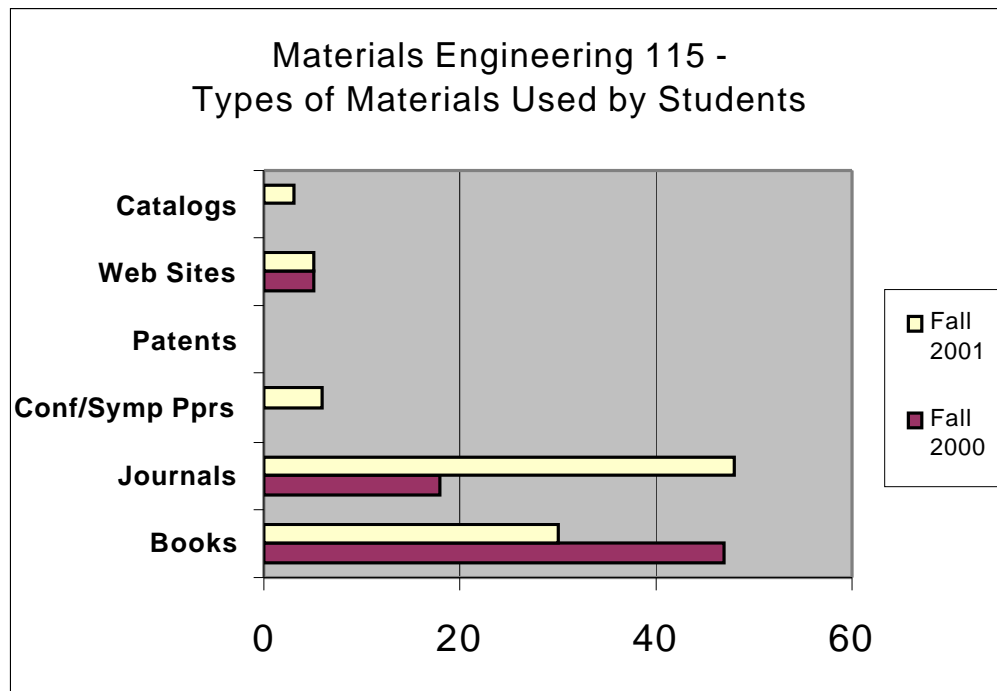


In Spring 2002 the Chemical Engineering 165 class was given access to the Chemical Engineering module with a short lecture by the librarians. After six weeks, the class completed a questionnaire that allowed us to see their patterns of use of the Chemical Engineering web module. (The results of that questionnaire are shown in Appendix C.) There were seventeen responses to the questionnaire in all. We gained valuable feedback on

the students' experiences with the web modules, as well as comments and suggestions for future modifications. Refinements in these modules will be made so that the modules can continue to be used in these classes.

Next, we examined the types of resources the students used in both classes both pre- and post- module to see what, if any, changes occurred in the students' choices of resources. Figure 3 shows the difference between pre- and post-module use of types of materials in the Materials Engineering 115 classes.

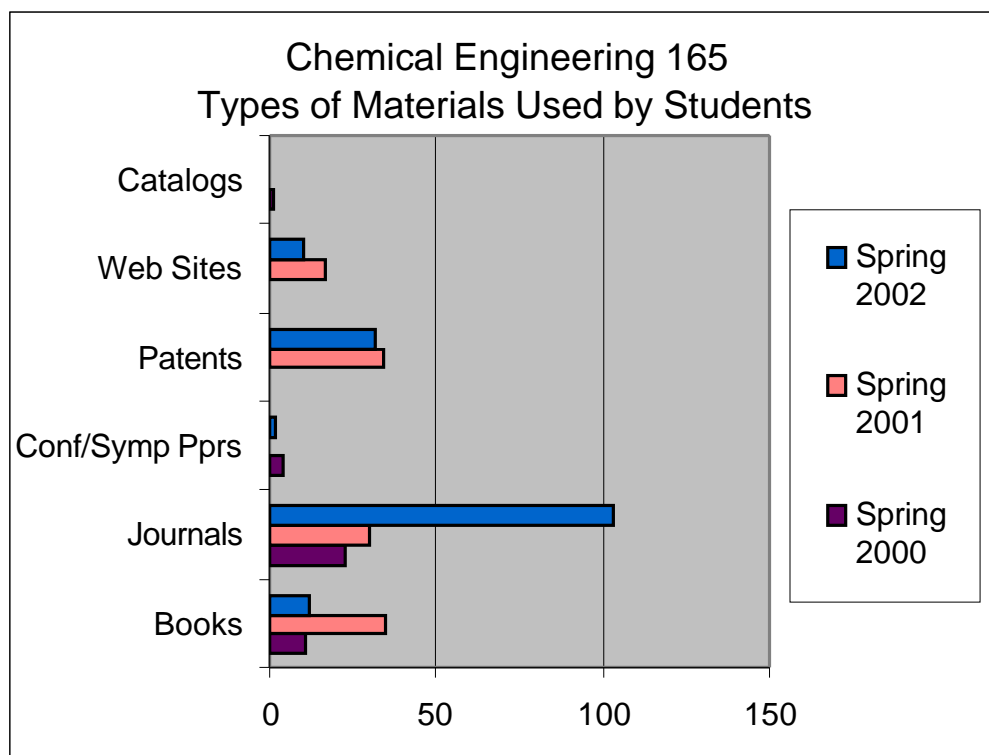
Figure 3 (Pre- and Post-Module Comparison)



In the post-module Materials Engineering 115 class the students found a greater number of references for their papers as well as a larger variety of resources. They depended less on books in the post-module class, and more on journal articles. Some conference papers appeared in their references also. Figure 2 and Figure 3 show a correlation between the increased number of journal articles and the currency of those publications.

In the Chemical Engineering 165 classes a similar pattern emerged (Figure 4). In the pre-module classes (Spring 2000 and Spring 2001) there was a greater dependence on books. After being introduced to the web module, students found many more journal articles for their projects. Patents are important to this class and the number used each year was similar (except for Spring 2000 for which we had only one project). Dependence on web sites (i.e. surfing the net) decreased somewhat.

Figure 4 (Pre- and Post Module Comparison)



Conclusion

The web modules we designed for Chemical Engineering and Materials Engineering have been frequently and successfully used by the classes to which they were introduced. We will introduce the web modules to a larger number of Chemical and Materials Engineering classes in the coming semesters. The modules are regularly updated and expanded to meet the research needs of our target audience. We also plan to utilize this concept in the development of more modules for other departments within the College of Engineering. In designing these electronic roadmaps for engineering students, we believe that students will be more motivated to help themselves to the rich variety of engineering resources now available both in the library and on the web.

References

1. Cannon, Anita. "Faculty survey on library research instruction". *RQ* (Summer 1994) 33: 524-41.
2. Leckie, Gloria J. and Fullerton, Anne. "Information literacy in science and engineering undergraduate education: faculty attitudes and pedagogical practices". *College and Research Libraries* (January 1999) 60(1): 9-29.
3. Rosenzweig, Mark and Gardner, Graeme. "ChEs see significant gains and changes". *Chemical Engineering Progress* (November 1994): 54-61.
4. *Statistical Abstract, San Jose State University 1995/96-1999/2000*. Pgs 57-63.

Appendix A

Chemical Engineering

Important!

Some parts of this module are available only to students, faculty, and staff of SJSU with a Library PIN and the current Proxy Password.

Chemicals

Equipment

Formulas, Properties, Data, etc.

Government Information

Patents

Process

Safety

Standards/Specifications

Research Project/Term Paper Guidelines

Professional Associations/Societies

FAQ's

Finding Info Fast

Finding Books

Finding Journal Articles

Locating Full-Text Journals

Ordering What SJSU Doesn't Have

Clark Library

Hours

Maps

Other Libraries

If you have any questions, please send an email to either:

Sandra Kajiwara or Cecilia Mullen

Engineering Librarians and Web Designers

Appendix B

Chemical Engineering

Process

- Encyclopedia of Chemical Technology
Long articles on the entire chemical industry, chemical technology, and allied fields
- Ullmann's Encyclopedia of Industrial Chemistry
Long articles on all areas of industrial chemistry and chemical engineering
- Exploring Materials Engineering
Commercial, academic, and government links to materials info provided by SJSU
Professor Emeritus Dr. Patrick Pizzo

In Our Library

- Perry's Chemical Engineers' Handbook
Chemical and physical properties, fundamentals, processes, materials and safety

If you have any questions, please send an email to either:

Sandra Kajiwaru or Cecilia Mullen

Engineering Librarians and Web Designers

Appendix C

Questionnaire on Engineering Research Web Modules

Chemical Engineering 165

How many times have you used the engineering web modules? - check one

<u>1</u>	One Time	<u>6</u>	Six to Ten Times	<u>1</u>	Never
<u>6</u>	Two to Five Times	<u>3</u>	More Than Ten Times		

Did you locate the information you needed through the modules? - check one

<u>4</u>	Yes, just what I wanted	<u>2</u>	Little helpful information
<u>10</u>	Yes, with limitations	<u>1</u>	No, found nothing

Which sections of the **Chemical Engineering** module did you find useful?

<u>8</u>	<u>Chemicals</u>
<u>4</u>	<u>Equipment</u>
<u>3</u>	<u>Formulas, Properties, Data, etc.</u>
<u>1</u>	<u>Government Information</u>
<u>12</u>	<u>Patents</u>
<u>8</u>	<u>Process</u>
<u>2</u>	<u>Safety</u>
<u>3</u>	<u>Standards/Specifications</u>
<u>1</u>	<u>Research Project/Term Paper Guidelines</u>
<u>0</u>	<u>Professional Associations/Societies</u>
<u>3</u>	<u>Finding Info Fast</u>
<u>3</u>	<u>Finding Books</u>
<u>11</u>	<u>Finding Journal Articles</u>
<u>13</u>	<u>Locating Full-Text Journals</u>
<u>1</u>	<u>Ordering What SJSU Doesn't Have</u>

Which sections of the **Materials Engineering** module did you find useful?

<u>1</u>	<u>Materials</u>
<u>0</u>	<u>Equipment</u>
<u>0</u>	<u>Formulas, Properties, Data, etc.</u>
<u>0</u>	<u>Government Information</u>
<u>1</u>	<u>Patents</u>
<u>1</u>	<u>Process</u>
<u>0</u>	<u>Safety</u>
<u>0</u>	<u>Standards/Specifications</u>
<u>0</u>	<u>Research Project/Term Paper Guidelines</u>
<u>0</u>	<u>Professional Associations/Societies</u>
<u>1</u>	<u>Finding Info Fast</u>
<u>0</u>	<u>Finding Books</u>
<u>0</u>	<u>Finding Journal Articles</u>
<u>0</u>	<u>Locating Full-Text Journals</u>
<u>0</u>	<u>Ordering What SJSU Doesn't Have</u>

Would you use the **Chemical Engineering** web module again? - check one

<u>12</u>	Yes, absolutely
<u>3</u>	Probably
<u>1</u>	Maybe
<u>0</u>	Never

Would you use the **Materials Engineering** web module again? - check one

<u>1</u>	Yes, absolutely
<u>1</u>	Probably
<u>2</u>	Maybe
<u>0</u>	Never

What had you hoped to find in these web modules that you didn't?

Answer summary: Students had no suggestions for adding to the web module beyond asking for more full-text journals articles and one person wanted e-text books. The other comments were that the web module was very helpful.

How would you change these web modules if you could?

Answer summary: One student wanted faster order time for articles; one wanted everything accessible from home. All other comments were positive, e.g., "I wouldn't change anything", "Good setup", and "It has been quite easy to use so far".

CECILIA P. MULLEN is currently an engineering librarian at San Jose State University, San Jose, California. She has over 30 years of experience as an engineering librarian in academic and special libraries. She has a bachelor's degree from Gonzaga University in Spokane, Washington and an MLS from the University of Washington, Seattle, Washington.

SANDRA H. KAJIWARA is currently a science/engineering librarian at San Jose State University, San Jose, California. She has over 25 years of experience as a science/engineering librarian at San Jose State. She has a bachelor's degree and a master's degree in Natural Science from San Jose State University and an MSLS from University of Southern California.