

## **AC 2009-1586: INTEGRATING INFORMATION LITERACY ACROSS THE ENGINEERING DESIGN CURRICULUM**

### **Barbara MacAlpine, Trinity University**

Barbara MacAlpine is Associate Professor and Science Librarian at the Coates Library of Trinity University in San Antonio, Texas. She received a B.A. in Psychology from Earlham College and a M.A.L.S. from the University of Wisconsin--Madison.

### **Mahbub Uddin, Trinity University**

Mahbub Uddin is a Professor in the Engineering Science Department at Trinity University in San Antonio, Texas. He received a Ph.D. in Chemical Engineering from Oklahoma State University. Dr. Uddin's research interests include stochastic modeling, pollution control, two-phase flow and engineering education. Dr. Uddin is a fellow of the ASEE.

# **Integrating Information Literacy Across the Engineering Design Curriculum**

## **Abstract**

This paper will examine the components of information literacy instruction at all levels of Trinity University's engineering program, indicating how they build upon each other and identifying what still needs to be added to integrate information literacy fully across the curriculum. Assessment of the engineering students in this area will be discussed, based on testing that began in the fall of 2007 and continues through the 2008-2009 academic year. The comments of the authors, representing both a librarian and an engineering faculty member, will provide a wider viewpoint that may inform planners at other institutions who are interested in expanding and integrating information literacy instruction across their engineering curriculum.

## **Introduction**

The need for information-literate engineering students continues to be addressed in the literature as well as by the ABET standards regarding the ability to engage in life-long learning.<sup>1,2,3</sup> Freshmen/first-year students are often targeted as the logical beginning for an information literacy program<sup>4,5,6</sup>, but additional instruction over succeeding years is highly desirable to build on that initial introduction to library research. While some repetition of resources and concepts is valuable to include in classes with sophomores and upper level students, a balance must be reached to avoid that common response of "I already know about that." Examples of information literacy across the curriculum of specific engineering departments have been described.<sup>7,8</sup> This paper addresses efforts to fit information literacy into a more general design curriculum that is in place at the authors' institution.

At Trinity University, a small liberal arts university with an engineering science department, a formal campus-wide information literacy program has been adopted that targets all students, at all levels of the curriculum and even across co-curricular activities (international programs, campus publications, athletics, community service, etc).<sup>9</sup> Its five major goals for students are that they learn to access, understand, and evaluate information, use it ethically, and create new material (papers, presentations, or other products) based on that information. While the university program started in the spring of 2008, progress toward its goals was already underway several years before within the eight-semester engineering design course sequence.

## **The engineering science design curriculum**

The Engineering Science program at Trinity University requires a minimum of 129 hours consisting of a 51-semester-hour engineering core, 33 hours in math and science, 33 hours in the common curriculum, and 12 hours of elective, leading to a Bachelor of Science in Engineering Science degree. Engineering students are also awarded a mathematics minor.

The multidisciplinary core engineering science courses emphasize critical and creative thinking and the development of student's communication skills. Engineering design, specifically creative design, is the central focus of the program. An eight-semester design course sequence

that begins in the first semester of the freshman year and terminates with a two-semester senior capstone design project forms the backbone of the curriculum.

The first design course introduces students to the engineering design process utilizing a competitive design project. The second semester freshman design course continues the introduction to engineering design concepts with another interactive team-oriented design project. Examples of freshman design projects include designing, building, testing and analyzing the performance of a wooden truss; designing, building and testing a water balloon launcher, etc.

Freshman design courses are followed by one-credit-hour mini capstone design projects in the sophomore and junior years. The sophomore design projects continues the development of students' design skills through a project with an emphasis on health and safety, manufacturability, sustainability, and economic, environmental, social, political and ethical design constraints.

The first design course in the junior year builds on the students' background in electrical engineering, while the second junior mini capstone course involves a thermal/fluids competitive design project. Examples of junior design projects include designing, building, and testing a traffic light control system; product redesign of appliances such as toaster ovens and popcorn poppers, etc.

The senior year capstone engineering design experience includes two three-credit-hour design courses in which year-long comprehensive projects are undertaken by groups of three or four students. By the time students reach senior year, they have experienced mini capstone projects in electrical, chemical, and mechanical engineering. In the development of senior design projects, industry/university partnerships are heavily emphasized.

### **Information literacy components**

One librarian at Trinity University serves as the liaison to the Engineering Science Department. Her participation begins with the initial course for first-year students and is integrated with a mini-design project. This first class session combines an introduction to very basic literature and patent databases with hands-on work and a small-group exercise focused on written communication in engineering. The emphasis is on accessing information, whereby students become familiar with sources that index and/or provide full-text publications. Students keep a research log, which is turned in with their project report. Initially taught to both sections of the first-year course in the fall of 2003, this information literacy unit is now a standard part of the class and has been utilized by three different faculty members as they have taught the course.<sup>5</sup> The librarian meets the students the first day of class, returns later in the semester to present information and lead the active learning components, and attends the group presentations of the mini-designs a few weeks later. While not exactly an embedded librarian, she is very involved with the students as they begin their engineering education.

Sophomore design students work on real-world projects. For the past two years those have involved adapting equipment, following specifications outlined by and contracted with Goodwill Industries. In the first semester students are required to do literature searches as part of the

research phase of the design process. Their library instruction offers a review of the patent literature along with an introduction to product sources and government standards. In addition to using the more typical sources of engineering information, these students must also explore the needs and capabilities of physically handicapped individuals who operate equipment in the workplace. Thus their research instruction includes resources related to products and to users who require adaptive features on their machinery.

At the junior level, in the second semester the students work in teams to examine electrical appliances, taking apart their products, rebuilding them, and researching ways to improve their performance and overall design. The information literacy instruction adds the exploration of safety requirements, component specifications and a focus on clear communication via user manuals. Because the students will develop suggestions for redesigning their appliances, they are given more extensive instruction for patent searching and begin to appreciate that literature on a deeper level.

Senior design projects, carried out in teams, are a year-long experience. Because these projects are very demanding, teams are encouraged to consult with the librarian during their initial investigation of problems and possible solutions. She also attends the seniors' formal design presentations at the end of the academic year. Over the past four years she has seen steady improvement in the resources used by the students and the extent to which they are referenced during the presentations. Outside the design sequence, students in some senior-level engineering classes are required to write a paper based on a literature review. At that point they are reintroduced to Compendex and more of the professional literature by the librarian. It is hoped that what they learn in the process of writing papers carries over to their research activities in the senior design projects as well.

## **Assessment**

Assessment during the early years of the information literacy engineering instruction was largely anecdotal. The faculty member who taught the Design I class had expressed dissatisfaction with the preponderance of citations reflecting Google searches in the mini-design reports. After the librarian became involved, he noted that the quality of cited material showed definite improvement. The research logs that the students turned in were their primary form of assessment and feedback. These were required for the final report, were graded by the librarian, and accounted for a small percentage of the final grade on the mini-design project. Almost all of them received the maximum number of points; many of them had good analyses of why a particular database (or Google) was most effective for their topic. While a few student groups reported spending only an hour on their library research, most of them spent significantly longer. Based on these responses, it was reasonable to say that the students learned about ways of accessing information beyond Google, could recognize which databases were most useful, and came to appreciate that the research portion of their design work was both more demanding and more productive than they had expected.

## **Assessment, 2007/2008**

During 2007 the Engineering Science Department requested an assessment by the librarian that would reflect progress toward the ABET Criterion Three Program Outcome that students attain “a recognition of the need for, and an ability to engage in life-long learning.”<sup>3</sup> More specifically from the information literacy instruction, they wanted an evaluation of the students’ abilities to identify and retrieve information. The librarian prepared a brief (7 question) test that addressed these abilities (see Appendix). The test was administered to a class of 34 senior students in the fall of 2007 at the beginning of a library research session. These were students who had received library instruction in the preceding three years. The test was initially intended to be given twice, as a pre-test and post-test, but the instructor’s time limitations toward the end of the semester resulted in no post-test. However, the questions covered concepts that were introduced and repeated in the earlier years, so one would hope/expect that students knew most of the material.

How did the students perform on the test? The mean was 5.12 correct, the median was 5 correct, while the mode was 6 correct. The most missed question was #5, “Periodicals (magazine, journals and newspapers) may be found in the Coates Library”, followed by a variety of location possibilities. This was incorrectly answered by 20 students, reflecting the fact that they tend to access articles electronically and are not as aware of how to navigate the library’s physical collection. Part of the reason for asking this question was to point out in the instruction that followed how a reorganization of the library had recently moved all of the engineering bound journals from the fourth floor to compact shelving on the first floor. In the bigger picture, it seems valid for students to learn that not all journals are available electronically, and that will be true after they leave academia as well. Thus some familiarity with print journals and how to locate them in a library collection is still important for life-long learners.

The other question that was missed by almost half the class (16) was #1: “Where is the first place you would search for authoritative information related to an engineering materials topic?” Possible answers included both Google and a library database of technical articles. Some of the incorrect answers were due to the wording of the question. At the beginning of the test several students asked if their answer should reflect what they really do or what the librarian might expect of them based on prior instruction. The result was some ambiguity as well as a bit of resistance by seniors who clearly weren’t taking the test very seriously. One who did answer the question correctly noted thoughtfully “although I do start with google and wikipedia for cursory information.”

### **Assessment, 2008/2009**

Due to scheduling changes there was no opportunity to test students in the fall of 2008. The second semester junior design students had an instruction session scheduled with the librarian in January 2009, and it was determined that testing at the beginning of that class would be the best opportunity to reach the most upper-level students. The test was administered to 26 students. All questions and possible answers were the same as in the 2007 test except question #1, which was modified to read: “What do you consider the most reliable source to search for authoritative information related to an engineering materials topic?”

Despite somewhat less library research instruction and experience, these students did slightly better than their 2007 counterparts: a mean of 5.27 correct answers, median of 5.5, and mode of

6. Once again question #5 about the location of print journals in the library was missed the most, by 22 students. It is apparent that this information continues to receive little stress in instruction and the material gets even less usage by the engineering students. Surprisingly, 12 students also answered question #4 incorrectly: “What type of publication is more research oriented?” Answers ranged from a) a magazine, b) a journal or conference proceeding, c) a newspaper, or some combination of those three possibilities. The most typical wrong answer grouped a) and b) together, suggesting that the distinction between journals and magazines has not been made clear. This is disappointing because it is emphasized at the first-year level, not only in engineering classes but also in many of the other university courses that are offered to first-year students and have an information literacy component. However, it is useful feedback to the librarian to make this a more prominent part of Design I instruction in future years.

In general it is the librarian author’s view that the students still turn to Google first to start their research investigation. However, they have learned to evaluate sources, from the web and elsewhere, and are much more inclined to use patent information and even the occasional article that addresses the design problem at hand. Assessment results thus far have been shared with the faculty in order to encourage a continuing relationship with the library’s information literacy program. They have also been used to make minor modifications in the librarian’s instruction sessions and to pinpoint areas that need greater assessment in the future.

### **Assessment by the faculty**

Feedback from the engineering faculty, while largely anecdotal, indicates that integration of information literacy across the engineering design curriculum has significantly helped to improve students’ technical writing skills. The content of their technical papers and design project reports are now more likely to include up to date information on the research and development of new engineering design materials, processes, products and services. Faculty members note that students have a better understanding of available bibliographic resources. They have shown improvement in identification, retrieval techniques and organization of information. Moreover, students have learned to optimize searching techniques necessary for design projects and library paper assignments. This observation is based on the research logs which are now utilized and turned in as part of project reports in a design class at the first year, sophomore, and junior level.

### **Conclusion and future plans**

Information literacy instruction for engineering science students at Trinity University has progressed from at most one class period in their four-year career to a planned sequence of formal meetings at least once a year. Almost all of the faculty have included either library instruction or one-on-one consultation with the librarian for the students in their classes, suggesting that they see the value of this process and support the information literacy goals of the library and the university as a whole.

In terms of the design classes, the senior year has been less structured, with librarian-student interaction left to the students to initiate. Faculty members continue to work closely with the librarian, and at her recommendation they will begin to require consultation with her by each

senior design team starting in the fall of 2009. The research logs that are required in years one through three will become a part of the senior design project as well.

Future instruction will take into account some of the weaknesses noted by student performance on the testing carried out already. More attention to the ethical use of information will also be a focus, in conjunction with the goals of Trinity University's information literacy program. This is likely to be emphasized in the sophomore year, when students are involved with real-world projects and can make the connection between how they use information and what effect that might have on their own work as well as on products designed for other people.

Assessment needs to be systematized, with testing administered at a defined time each year on an instrument that is modified to become more rigorous and to include additional resources, especially the patent literature. It has been suggested that the test could be given to the first-year students as a pre-test and then repeated in each of their next three years to show the progression of their learning. The authors intend to implement such a plan in the fall of 2009. To satisfy ABET standards more fully, and to strengthen the assessment component of the university's information literacy program, we hope to develop a formal mechanism by which faculty can measure the quality of resources used in student project reports and papers.

Trinity University has embarked on a five-year program to integrate information literacy into all aspects of academic life. It is hoped that many, if not all departments will eventually have information literacy components across their curriculum. At this early stage the Engineering Science Department is leading the charge and already close to achieving that goal, thanks in large part to faculty members who saw positive changes in one or two classes and decided to build on that success for all their students.

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**APPENDIX. Information Literacy Test for Engineering Students**  
Coates Library, Trinity University, San Antonio, TX

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1. Where is the first place you would search for authoritative information related to an engineering materials topic?
  - a) howstuffworks.com
  - b) Google
  - c) A library database of technical articles
  - d) Your professor's bookcase
  
2. If you were searching for information on materials used in nanotechnology applications, which keyword search would retrieve the most relevant information?
  - a) (nanotechnology applications) OR material\*
  - b) (nanotechnology applications) AND material\*
  - c) (nanotechnology applications) OR materials
  - d) nanotechnology
  
3. Full-text journal articles may be located
  - a) in the library
  - b) through the Journals link on the library's homepage
  - c) via a request from ILLiad (interlibrary loan)
  - d) all of the above
  
4. What type of publication is more research oriented?
  - a) a magazine
  - b) a journal or conference proceeding
  - c) a newspaper
  - d) A and C
  - e) A and B
  
5. Periodicals (magazine, journals and newspapers) may be found in the Coates Library
  - a) on the first floor
  - b) on the second floor
  - c) on the third floor
  - d) on the fourth floor
  - e) all of the above
  - f) A and B and C



6. If your research topic focused on solar panels, which of these sources would you expect to provide the most reliable information?

- a) [http://en.wikipedia.org/wiki/Solar\\_panel](http://en.wikipedia.org/wiki/Solar_panel)
- b) the book Home heating solar heat panels (Independence, CA, Solar Concepts, 1973)
- c) [http://www.otherpower.com/otherpower\\_solar.html](http://www.otherpower.com/otherpower_solar.html)
- d) Solar Energy, a technical journal of the International Solar Energy Society
- e) [http://www.asu.edu/news/stories/200705/20070507\\_solarpanels.htm](http://www.asu.edu/news/stories/200705/20070507_solarpanels.htm)

7. When using a website, one should evaluate which of the following criteria to determine how authoritative it is? (Circle the five most important criteria.)

- a) "publisher" (organization, company, institution, or individual)
  - b) number of links on the page
  - c) language in which it was written (French, Dutch, English, etc.)
  - d) author
  - e) date it was posted
  - f) amount of advertising
  - g) purpose of the website (to educate, advertise, inform, persuade, etc.)
  - h) country in which it was produced
  - i) accuracy of the information
  - j) attractiveness of the graphics
  - k) how often you laughed while using it
-