AC 2007-1391: A LAB FOR ALL SEASONS, A LAB FOR ALL REASONS: COLLABORATIVE REPRESENTATIONS OF ENGINEERING WITHIN THE UNIVERSITY

David Ollis, North Carolina State University

© American Society for Engineering Education, 2007

A Lab for All Reasons, A Lab for All Seasons: Enlarging the Participant Base

Abstract

A "device dissection" laboratory, based initially on light driven devices, was conceived and realized in the early 1990s as a means of introducing new engineering students to the field of engineering[1]. The varieties of summer and semester engineering uses for this facility were summarized in an earlier paper[2] of related title "A Lab for All Seasons, A Lab for All Reasons." The present paper, "A Lab for All Reasons, A Lab for All Seasons: Enlarging the Participant Base," extends utilization of our engineering laboratory to non-engineering faculty and to non-engineering students. The first of these newer forays involves utilization of the lab as an enrichment adjunct to courses taught in other non-engineering departments, here with examples from Foreign Languages and Literatures, and Industrial Design. The second involves a new Technology Literacy course created for non-engineering students, and taught with the assistance of an English department faculty member (also serving in the College of Engineering's Writing Assistance program). Collectively, these three instructional efforts illustrate collaborations with faculty and students in non-engineering disciplines, and are thus examples of multidisciplinary forays in technology education, in which one discipline is always engineering. Further, our Technology Literacy course and the Spanish foreign language course both satisfy Science, Technology, and Society (STS) distribution requirements for non-technical and technical students, respectively. As such, these course are examples of liberal education for students in complementary majors.

Introduction

In the 1990s, we developed an extensive "device dissection" laboratory experience for entering engineering students[1]. The laboratory originated from a series of light-driven devices (bar code scanner, compact disc (CD) player, facsimile machine (FAX), digital and video cameras, photocopy machine, optical fiber communications, and ultraviolet water purifier) derived from the author's research interests in light-activated semiconductors. Graduate students in a 1992 version of Photochemical Engineering wrote the initial lab instructional drafts. Subsequently, these devices were supplemented with others including those common to the mechanical engineering device dissection labs[3] pioneered by Sheri Sheppard (Stanford) (electric drill, internal combustion engine, bicycle) as well as (model) airplanes, acoustic and electric guitars, the Internet (virtual device) and cell phones.

Copyright @ 2007 American Society of Engineering Education

We previously reported the use of our laboratory for engineering students under a variety of formats[2]:

- Engineering summer camp
- Engineering minority orientation week
- First year, one semester course[1]
- Laboratory-English course pair[4,5]

These multiple formats for early engineering students were summarized in our ASEE 2000 paper, "A Lab for All Seasons, a Lab for All Reasons.".[2]

The present paper is a similar summary and recapitulation paper, comprising explanation and analysis of subsequent configurations for lab use. In particular we report our new directions: that of providing the lab as an educational aid to faculty in other colleges, and to non-engineering students via a new Technology Literacy course. These more recent efforts represent our collective collaboration experiences which illustrate engineering's potential for outreach to the rest of the undergraduate campus. Such outreach provides a "service course" or extension philosophy, and could provide a national pathway for raising engineering's status as a campus citizen, by explaining technology, not simply to its own students (as is typical of other professional schools (law, medicine, business), but also to faculty and students in other colleges.

We believe that these collective experiences open a new viewpoint through which to view engineering, namely via the devices engineers design and build, rather than the current pathway which over emphasizes basic sciences (math, chemistry, physics) as well as engineering science (analysis) at the expense of "hands-on" activities and synthetic, creative opportunities.

The three following collaborative, multidisciplinary examples each present the description of a pre-existing course, its modification to allow inclusion of engineering devices and technology, and our current status in evaluation and assessment for each essay.

Foreign language course: "Spanish: Language, Technology, and Culture"[6]

Original course

The course, "Spanish: Culture, Language, and Technology", was designed specifically to encourage engineers to study a foreign language. A number of components of the course were incorporated with just this end in mind. The prerequisite for the course was set at two years of high school Spanish, a level that would not intimidate prospective students. This proficiency allowed the course to be taught at the intermediate level. Wireless laptop technology was integrated throughout the course, appealing to engineers' interest in and love of technology. To make the course even more attractive to engineers, it was designed to satisfy the science, technology, and society (STS) requirement of curricula in the College of Engineering. This was crucial, as the engineering curriculum is particularly tight. If the class didn't satisfy a College of Engineering requirement, many

Copyright @ 2007 American Society of Engineering Education

students might regard it as a luxury they could not afford. Finally, the class is offered as a prelude to an optional study abroad program, which includes lectures from visiting engineers and visits to technical sites in Spain. Our argument used for a class from the Foreign Languages and Literatures Department fulfilling a science, technology, and society(STS) follows. It was written for the Council on Undergraduate Education which approves curricular requirements at N.C. State.

> "One of the goals of the class is to go beyond the limits of a traditional language course and introduce the students to Hispanic cultural values and to explore how those forces shape and guide the development and utilization of technology. As they do so, our course Foreign Languages in Spanish (FLS) 212 more than teaches them the vocabulary of technology in Spanish; it also leads them to consideration of how cultural forces of a society are expressed and preserved in technology and how science and technology in turn influence the shape and direction of a society."

NC State STS goals

As with many campuses, the course was formatted to address the local goals for membership on the campus Science, Technology, and Society (STS) list. Address of theses goals is, from experience, a necessity if the course is to be elected by a substantial number of students. Engineering curricula are so constrained in terms of free electives that only a course which satisfies a distribution requirement has a likelihood of long term success. These campus goals are:

> Development of an understanding of the influence of science and technology on civilizations
> Development of the ability to respond critically to scientific and technological issues in civic affairs .
> Understanding the interactions among science, technology and values.

Course modification to include lab components

We adapted our take apart lab of consumer electronic and household devices to teach young engineers both the vocabulary and modes of thought of their profession, in Spanish, and to demonstrate the lab to be an effective teaching tool in the class: Spanish: Language, Technology, and Culture"

Following the format of our original product and process laboratory for engineering students[1] our language students worked in teams of four, beginning by researching the history and principles of their device, both in English and Spanish. They used the device to evaluate its functionality and disassemble and reassemble it to study its optics, mechanics, and circuit boards. Subsequently, they presented their device to other students, in Spanish. Thus, they furthered their knowledge of device, language, and culture. In doing so they derived all the benefits of the original language program and also expanded their Spanish engineering vocabulary and developed their technical

Copyright @ 2007 American Society of Engineering Education

presentation skills in a language that is in fact becoming a necessity in our global community.

A technical lab notebook was created for each device. The 20-30 page notebook consisted of technical explanation of device structure and operation, diagrams, short problems, and questions. The original notebook materials were prepared for a "device dissection" laboratory for incoming engineering students, and our experiences with this format have been reported previously.

The Spanish language instructor modified these materials in the following ways: First, she translated several pages of introduction and history for each device. The initial lab procedures were also converted to Spanish, including dissection and assembly instructions. The last few labs were in English so the students experienced working from Spanish-to-English and English-to-Spanish. There were four activities/lab and three problems for calculations.

For the oral presentation, students created Power Point slides that described their lab process, explained the cultural importance of their device, imported vocabulary which the whole class should know, and illustrated one calculation that was a part of the lab.

Visiting Lectures

A series of engineering faculty visited the class and spoke, in English, about a favorite topic. Students made vocabulary lists based on the lectures and wrote summaries of the substance of the lectures, in Spanish. Apart from the direct benefits to aims of the class, these lectures also gave the students an idea of the exciting work going on in various engineering labs across the campus.

Science, technology, society projects

All students completed two science, technology, and society projects. Working in teams of three and imitating the work in the "take-apart" lab, they studied an artifact of the Hispanic world. Their task was to research and describe the historical significance and engineering importance of the artifact and then to explain how the artifact reflects the culture which produced it. The fruits of these activities were two group presentations during the course of the semester –practicing the final methodology of the end project— and a group paper in English to summarize their project in Sevilla, Spain, and in Milwaukee, Wisconsin, two cities seemingly disparate in culture.

Evaluation and assessment of collaborative effort

The end-of-semester student questionnaire results appear in Table 1.

Proceedings of the 2007 American Society of Engineering Education Conference and Exposition
Copyright @ 2007 American Society of Engineering Education

Table 1

Student Survey Form and Results Summary:
Did the lab component enhance achievement of course learning objectives ?

This brief survey explores the degree to which the addition of a ‘hands-on” laboratory component to your course, “Spanish for Engineers: Language, Culture, Technology”, has enhanced the achievement of student learning objectives for the course. Four of the Spanish instructor’s six learning objectives relate directly to the laboratory experience, and associated class reports. Please indicate your judgment providing achievement of these four objectives:

Spanish instructor’s learning objective: (below)	Statement: The laboratory component contributed to achievement of this learning objective:			
Students will:	AGREE STRONGLY	AGREE	NEUTRAL	DISAGREE
Learn vocabulary commonly used in engineering and technology contexts	9	5	1	0
Develop the ability to comprehend and use Spanish in settings encountered in our technological society	7	8	0	0
Understand guides to cultural and engineering sites; understand cultural and historic importance of artifacts in Hispanic world: Roman aqueducts, cathedrals, castles, paintings, and basic principles of architecture	8	4	2	1
Interact in a more formal setting such as presentation of an engineering project	5	9	1	0

These results demonstrate that students believed the integration of a laboratory experience, including class discussions, website reporting, and oral and written

Copyright @ 2007 American Society of Engineering Education

presentations, provided a clear enhancement to achievement of the Spanish instructor's original student learning objectives. Thus, this cross-college collaboration is promising and the Department of Foreign Languages and Literatures has agreed to sponsor the collaboration in the future as a lecture and laboratory course.

Focus groups discussions were conducted by Dr. Rebecca Brent, Education Design, Inc., Cary, NC, and included two sets of student participants: the enrolled students and the undergraduate lab assistants. Both sets agreed that "Learning Spanish vocabulary in the take-apart lab " was very effective.

We conclude that this first collaborative example provided one validation point for our overarching hypothesis that "A device dissection laboratory may assist faculty in other colleges with achievement of their student learning objectives for a course with a substantial technical component.

Industrial Design: Junior Studio[7]

Original course

Industrial Design is the field concerned with the creative development of products that people use. The professional area of application is quite broad, ranging from transportation design, consumer electronics, medical products, toys, and everything in between. The curriculum for students of industrial design is also wide-ranging, having to account for principles of visual design and aesthetics, basic understanding of human factors, ergonomics and psychology, knowledge of the materials and processes of manufacturing, and expertise in the use of both traditional sketching and computer-aided design tools.

The most influential course in design education is the Studio. This is a 6 credit hour course that meets three days a week for three hours a day. Average class size is from 10 to 15 students. The students have an assigned desk, where they spend most of their time, even outside of regularly scheduled class hours, building and developing their projects. The faculty member teaching the studio course has a great deal of contact with the students, both on an individual basis working at their desk, and in small groups. The studio course also makes extensive use of group critiques, where everyone is required to display their projects at various stages, and defend the validity of their work at that point.

This teaching method is the heart of design education, and the process of routinely critiquing the work from the outset of each project requires the student to continually revisit the project goals and evaluate his or her proposed solutions against that framework of criteria. This method also reinforces in the students the importance of making their design process public and visible in order to get clear feedback along the way.

The studio courses are sequentially arranged throughout the eight semesters of the four-year undergraduate program, with the projects becoming progressively more challenging each year. During the sophomore year, students complete two 3 credit hour service

Copyright @ 2007 American Society of Engineering Education

courses that deal with methods of manufacturing and the use of materials. One of the expected outcomes of the third year studio is that the projects demonstrate the students ability to effectively apply what they learned about manufacturing to the design of their products. The fall semester Junior Studio was chosen for collaboration with our device laboratory, because this studio seemed a good place to include device content related to the technology embedded in the product itself.

Modification to include lab components

The new course was to begin by allowing the students to choose between two projects, a portable CD player, or an electric guitar. The industrial design students were to 'dissect' the product they chose as a group, under the guidance of the teaching assistants, who were seniors in engineering. Once the design students understood the existing product and its underlying operating principles, they were to develop designs for a new version of the product, based on either the current state of the technology, or an informed projection of what would be possible in the foreseeable future.

As the course was originally envisioned, the design students would work largely in the product' take apart' laboratory throughout the semester. We discovered fairly early in the actual course that the use of the engineering lab had to be meshed with the Design Studio culture. At the beginning, the device lab proved an essential setting for the projects, as the design students took apart the products and discussed the underlying principles of their operation with the teaching assistants. After the initial two weeks of gaining familiarity with the existing products, the faculty became aware that the students needed to gravitate back to working in the design studio. Part of the need to work in the studio was to have the desk space necessary to draw effectively, and students also required the studio's proximity to the College of Design computer lab, and shop. Both of these facilities are essential to the design student's working process, providing them with the means to produce models either in physical or virtual form. Initial product models are often made quickly, cut out of various types of foam, or modeled from wood or fiberboard. Building these 'sketch models' throughout the design process provides several benefits, such as imparting a sense of scale, or the ability to investigate how a product fits in the hand. Later models that are highly finished can be produced either in the shop or by means of computer modeling.

As the design students moved into the concept development phase, it was decided that the teaching assistants from engineering would come into the design studio, instead of only being on duty in the product laboratory which is located in the College of Engineering. It was through this somewhat unexpected development that the course began to take on additional dimensions beyond its primary goal of imparting technical knowledge to the design students. The design studio, where each student has his or her own work area, provided a less formal setting. This fact, combined with the open layout of the room, allowed the teaching assistants to work with the design students within both individual and group sessions, and to collaborate in the development of the projects. Also, the change in setting allowed the teaching assistants the opportunity to gain insight into a

Copyright @ 2007 American Society of Engineering Education

learning environment different than that to which they were accustomed and to experience creatively focused learning and working methods.

A significant change was noted in the effectiveness of achieving the courses main goal, that of promoting innovative use of technology by the students, when the teaching assistants began to take an active role in the scheduled critiques. The design critique is a setting where feedback is immediate, public, and notoriously honest. It was in this setting of verbal debate over each student's work and their ideas regarding design and the application of technology that the faculty began to see results that had been unattainable in the past. Student designs in this review were more creative in their use of technology than in the past, and technical feasibility could be proven, disproved, or improved upon, on the spot. It was particularly gratifying to witness that the teaching assistants from engineering were encouraging of the design student's creativity, even on some of the most radical ideas, and that they had become key players in shaping the details that would make a project work.

Selection of the Teaching Assistants

We were quite fortunate in the engineering teaching assistants who were selected for the pilot test of the course, in that they both possessed qualities that we now recognize as essential to the success of the course in the College of Design. These were seniors quite knowledgeable in their own field of mechanical and electrical engineering, and also open-minded and interested in other disciplines as well. This resulted in an open atmosphere among all students, and made them more willing to explore the overlapping interests between the College of Design and the College of Engineering. We have observed anecdotally that in professional practice, there is sometimes a tendency for barriers to exist between any two disciplines, with negative expectations of the aptitudes and motivations of disciplines other than one's own taking precedence over actual personal experience. By establishing links between related professions at the university level, the way is paved for more effective collaboration in the student's future careers.

Evaluation and assessment of collaborative effort

This studio section (one of three offered) of the junior year Studio involved nine Industrial Design students, a typical section size. Each student was interviewed by Dr. Rebecca Brent at semester's end. Taken together, Table 2 reports their comments nearly verbatim, in two categories: "Things that worked to help them learn" and "Challenges and barriers to their learning". Author remarks are in parentheses.

These results indicate that the design and lab assistant students both viewed the experiences with the lab devices as positive. Two themes are of particular positive note: design student opportunity to use, dissect and work directly with commercial devices, and realization of cross-college collaboration of students, not just instructors. Opportunities for improvement include installation of updated products in the lab (design activity must be "cutting edge"). From earlier design instructor comments, and from the student

Copyright @ 2007 American Society of Engineering Education

Table 2

Lab experience assessed by Industrial Design students

Things that worked to help them learn

> Visualizing how things fit into space, "making it real".
> Feedback from the engineering student lab assistants during progress display (pin-up) session.
> Having the lab assistants present as a resource, especially in the studio.
> Engineering assistants were not conceptually limiting; they used their imagination.
> Working in a (design student) group at the beginning when in the engineering lab.
> Prepared design students for real world where designers and engineers work together.
> Engineering instructor was helpful in pin-up sessions and desk critiques.

Challenges and barriers to their learning

> Hard to identify a new design problem, given a lab device.(i.e., no customer or safety or aesthetic complaint given to start design approach)
> Devices were often older devices, not cutting edge versions.
> The separate engineering lab didn't fit with the way designers work.
> Would have liked to "check out" the device and live with it while they were working. A number of students bought their own devices.
> Would have liked to see a female lab assistant (Industrial Design enrollment is about 40% female).

---

feedback via interviews, we conclude that the device laboratory clearly provided an enhancement of learning opportunities in industrial design, as hypothesized in our original proposal.

The two engineering lab assistants were also interviewed by Dr. Rebecca Brent, and their comments are summarized in Table 3 below.

Copyright @ 2007 American Society of Engineering Education

Table 3

Lab experience assessed by engineering student assistants (seniors)

Things that worked for the ID students

> Taking things apart in groups.
> Asking questions rather than reading the (30 page) documentation.
> Sketching is the way the ID students think, not reading the documentation.

Suggestions or changes they would recommend

> Students didn't need the initial three days in a row in the lab. Could have moved more quickly to the studio.
> Have lab assistants in the studio more than one day a week so questions could by answered more quickly (initial hour each period would be OK).
> Students would be more excited if they could take home the device they want to work on.
> Lab needs more clear work space.

These comments indicate that design students could profit from more instruction-demonstrations at the outset by instructor and/or lab assistants, and that allowance for check-out or lab devices (or even outright purchase) for the design students would be beneficial to connecting devices to the design challenges.

We conclude that this second collaborative example provided another validation point for our overarching hypothesis that "A device dissection laboratory may assist faculty in other colleges with achievement of their student objectives for their course with a substantial technical component."

Technological Literacy a.k.a. "How stuff works"[12]

Original course: Krupczak model.[8-11]

Hope College's John Krupczak has developed and taught a Technological Literacy course which includes three lectures/week and an associated three hour laboratory. The lectures explain the technology and science principles underlying common devices including the automobile, electric motors, telephones, and the radio. His science-based course includes both take-apart and reassemble activities, as well "make and take" exercises in which the students can take home the product of their lab endeavors , such as a simple motor or radio receiver.

Copyright @ 2007 American Society of Engineering Education

Modification to include NCSU lab components[12]

We have developed a related technology literacy course, which has a weekly format involving lectures, lab, and outside readings, with the following characteristics:

CONTEXT: Lecture 1 defines the historical origin and technical evolution of prior devices which served the same or related functions (e.g, for the digital camera, lecture surveys optics, drawing, camera obscura, Daguerrotype, black /white film, Kodak and the personal (Brownie) camera, color film, Polaroid camera/film, and video camera).

CONTENT: Lecture 2 describes the principles and key operations of the modern device (e.g., digital camera: optics, automatic focus, digital image function and resolution (pixels), digital image storage and retrieval, digital image printing resolution (dpi) and software editing of image).

CONTRAPTION: A two hour lab period provides students with opportunity to use, dissect and reassemble a device at a basic level, sufficient to encounter major process paths for, e.g. flow of material (e.g., paper in FAX and photocopy), photons (bar code scanner, camera, optical fibers, FAX and photocopy), and energy (guitar, engine, bicycle), etc.

CASE: For outside reading and writing, students explored our lab library, from which they chose and read one book per month, then wrote a paper analyzing a technical topic involving development of a commercial device (first month), a technology company (second month), and a technology hero (third month). Respective examples are the creation of a new computer in Kidder's The Soul of a New Machine, the history of he Edison Electric Company, and Jeff Bezos' biographical story in Amazon, Inc.

Over the semester, the students thus receive a broad view through the fourteen initial weekly lectures, akin to a typical "survey of Western literature or philosophy course", then a second lecture series of explanations of everyday devices in their lives, and finally a weekly "hands-on" laboratory, involving team-based opportunity to use and take-apart current technologies. Beyond this broad encounter with multiple technologies, via context, content, and contraption, the students follow their individual interests through reading and analyzing three books which focus individually on a device, a company and a technology hero, but broadly described so as to include, again, "context, content and contraption".

This multi-dimensional approach to technology literacy is a new format for delivery of this topic. As no consensus structure appears to yet exist for technology literacy courses[13], our form provides another choice of "Tech Lit" delivery mode for the general college populace with interest, but not expertise, in technology.

Copyright @ 2007 American Society of Engineering Education

Defining the topics

Our Technology Literacy course for non-technical students was to be based primarily on the devices existing in our engineering device dissection laboratory. Devices visited, one per week, in the corresponding weekly laboratory period are bar code scanner, compact disc player and burner, FAX machine, electric and acoustic guitar, electric drill, bicycle, internal combustion engine, optical fibers, photocopy and scanner, digital and video camera, cell phones, and airplanes.

The lecture topics are arranged in pairs, with a first presentation summarizing the historical evolution of preceding technologies, and the second describing a modern descendant of this evolution. An example: for electricity, the first class surveyed "Electricity to work: from Franklin to electric power", and a second lecture titled "Electric motors and drills". The complete lecture topic sequence for fall 2004 appears in Table 4 below.

Table 4:
Lecture Topics for Technology Literacy

Evolutionary Context	Modern Example
Introduction to technology	Engineering: "Design under constraints"
Fuels to work: from fire to engine	Internal combustion engine
Electricity to work: from Franklin to electric power (AC and DC)	Electric motors and drills
Exchanging electrons for information: telegraph, telephones, and cell phones	Cellular phone networks
Catching the light: Archimides to optical fibers	Optical fiber systems
Tracking materials in commerce: from barter to bar codes	Bar code systems
Producing sound: from Galileo to Grunge	Acoustic and electric guitars:
Recording images: from Niepce to digital cameras	Digital cameras
Recording sound: piano rolls to compact discs	CD "burners"
Reproducing information: from Gutenberg's press to photocopy and scanner machines	Black/white and color photocopy
Making new materials: from ceramic alchemy to semiconductor science	The integrated circuit
Computers: Eniac to Apple	Personal computers
Flight: ancient gods to Wright brothers	Modern jets (and models)

Copyright @ 2007 American Society of Engineering Education

Exploring individual technology cases through essays

The essay assignments were designed to encourage students to follow their individual technology interests. Three papers were to be written, one per month, with a focus on a device, a person, and a company, respectively. Students were given the opportunity to choose books from our lab library of about 600 volumes. The entire book(300-600 pp) was to be read, thereby providing a complete case study of device, company or person, as appropriate. Each reading was followed by creation of a written essay in response to the criteria and questions below in Table 5 (example for an important person in technology development).

Table 5
Writing Assignments (three per semester)

Week one: Choose a book (student choice with consent of instructor, or instructor suggestion, dealing with a substantial technology advance, person, or company)

Week two: Read entire book.

Week three: Summarize the book in a single page (three paragraphs), which explain

1. What were the social and technical settings of the time ?
2. What was the particular technical challenge addressed, and why was it important ?
3. What was discovered/found, and how was it received by competitors, professionals (corporate management, etc), family, friends and society ?

Week four: In nine-ten pages, respond to the following questions:

1. What technical challenge did s/he address?
2. Why did the investigator(s) undertake the task(s) of interest ?
3. What achievement or resolution of the technical challenge was resulted?
4. What social challenges arose during the individual or team effort, and how were the social challenges resolved ? (within a corporation ? family ? society at large ? other ?)
5. What recognition, if any, did the investigator receive ?

Paper (summary plus full text) due end of week four. (repeated for weeks eight and twelve)

Copyright @ 2007 American Society of Engineering Education

The writing was evaluated by two faculty: the author-instructor (engineer), and a second, a former English instructor, Gary Weinberg, who leads our Writing Assistance Program in the NCSU College of Engineering. The students enjoyed the freedom of topic choice, and felt they learned appreciably from the written assignments. Mr. Weinberg's comments and suggestions on the written materials indicated a strong need for such formal feedback. This second disciplinary critique for the written materials be continued, and Mr. Weinberg's participation as consultant and grader will be more formally included in the subsequent versions of the course.

Evaluation and assessment of collaborative effort

To provide a basis for course evaluation, the following statement appears now in our current new course description (Table 6):

Table 6
Technology Literacy: Student Learning Objectives

"Students in this course will:

(1) Develop a basic conceptual framework and vocabulary for describing the technical and historical origins of modern technological devices
(2) Explain the conceptual operating bases of current and prior technologies which address similar societal needs
(3) Use and dissect devices to develop understanding of the relationships between technical subsystems of a device (e.g., the optical, electrical, and mechanical subsystems of a facsimile (FAX) machine), and their influence on device design and operation.
(4) Develop an understanding of the impacts (technical, economic) of a device in a given context, through lecture and individual analytic written papers.

What did the students learn ? An early class (7 students; 6 evaluations returned) provided the responses of Table 7 We conclude that this third collaborative example provided a final validation for our overarching hypothesis that a device dissection laboratory may assist engineering/English (multidisciplinary mix) faculty with achievement of student learning objectives involving literacy in the broadest sense.

In this last example involving non-technical students, the lab/lecture course also contributes to the liberal education of our broader student population.

Acknowledgement: Funding for development of our "Technology Literacy" course by the National Science Foundation (DUE-0126876) (CCLI-Adaptation and Implementation) is gratefully acknowledged. The cross-college collaborations were funded also by NSF, via a National Science Foundation DTS award.

Copyright @ 2007 American Society of Engineering Education

Table 7

Learning objectives and evaluation results for Technological Literacy course

Learning Objective: (below)	Hypothesis: The laboratory component contributed to achievement of this learning objective:			
Students will:	AGREE STRONGLY	AGREE	NEUTRAL	DISAGREE
Develop a basic conceptual framework and vocabulary for describing the technical and historical origins of modern technological devices	2	4	0	0
Explain the conceptual operating bases of current and prior technologies which address similar societal needs	3	3	0	0
Use and dissect devices to develop understanding of the relationships between technical subsystems	4	2	0	0
. Develop an understanding of the impacts (technical, economic) of a device in a given context, through lecture and individual analytic written papers.	4	1	1	0

References

1. Beaudoin, D. and Ollis, D., "Freshman Laboratory for Product and Process Engineering", J. Eng'g. Education ,July, pp 1-6., 1995
2. Ollis, D.F., "A Lab for all Seasons, A Lab for all Reasons," ASEE, 2000 Brown, A. and D.F. Ollis, "Team Teaching: A Freshman Rhetoric and Laboratory Experience," ASEE, Washington, DC, June, 1996.

Copyright @ 2007 American Society of Engineering Education

3. Sheppard, S. , Proceedings of the Engineering Education Curriculum Innovation & Integration Conference, Jan 6-10, 1992, Santa Barbara, CA. , http://www-cdr.stanford.edu/images/Dissection/dissphil.pdf
4. Brown, A. and Ollis, D. , "Team Teaching: A Freshman Engineering Rhetoric and Laboratory", ASEE proceedings, 1996
5. Brown, A., Luyendyk, S. and Ollis, D.F., "Implementing an English and Engineering Collaboration," in Liberal Education in Twenty-First Century Engineering: Responses to ABET/EC2000 Criteria, (eds: Ollis, D.S., Neeley, K.A., and Luegenbiehl, H.C., Peter Lang Publishers, New York, NY, pp. 270-279.
6. Kennedy, A., Ollis, D., and Brent, R, , "Cross-College Collaboration to Enhance Spanish Instruction and Learning," Proceedings of ASEE Annual conference, 2005.
7. Laffitte, B., Ollis, D., and Brent, R.,, "Cross-College Collaboration of Engineering with Industrial Design" Proceedings of ASEE Annual conference, 2005.
8. Krupczak, J., "Science and Technology of Everyday Life: A Course on Technology for Liberal Arts Students," Proceedings of ASEE Annual conference, 1996
9. Krupczak, J., "Demystifying Technology," PRISM magazine (ASEE), October, 1997.
10. Krupczak, J., "Reaching Out Across Campus: Engineers as Champions of Technological Literacy," in Liberal Education in Twenty-first Century Engineering, (editors: Ollis, D.S., Neeley, K.A., and Luegenbiehl, H.C., Peter Lang Publishers, New York, NY, 2004, pp. 171-188.
11. Krupczak, J., et al., "Hands-On Laboratory Projects for Non-Science Majors: Learning Principles of Physics in the Context of Everyday Technology," J. Krupczak et al., Proceedings of ASEE Annual conference, 2006.
12. Ollis, D., "Technology Literacy: Connecting through Context, Content, and Contraption.," Proceedings of ASEE Annual conference, 2005.
13. Krupczak, J. and Ollis, D., "Improving the Technological Literacy of Undergraduates: Identifying the Research Issues", Final report, NSF workshop , April 18-19, 2005, NAE, Washington, DC.

Copyright @ 2007 American Society of Engineering Education