

Cross-College Collaboration of Engineering with Languages, Education, and Design

David Ollis, College of Engineering, NCSU
Ana Kennedy, College of Humanities and Social Sciences, NCSU
Bryan Laffitte, College of Design, NCSU
Rebecca Brent, Education Designs, Cary, NC

Abstract

We report cross-college faculty collaborations through the co-teaching, or supplementation to, existing courses in the College of Humanities and Social Sciences (CHASS), the College of Education, and the College of Design. In particular, we explore the utilization of appropriate technologies from an engineering device dissection laboratory in order to enhance achievement of course and student learning objectives in four courses with substantial technical content:

Spanish: Language, Technology, and Culture (CHASS) (Fall, 2004)
Design Studio (Design) (Fall, 2005)
Communication Technologies (Education)(Spring 2005)
Computer Technologies (Education)(Spring 2005)

The overarching objective of the collaboration is to demonstrate the utility of a shared, central campus engineering laboratory as an enhancing and enriching agent for non-engineering courses with appreciable technical themes or components.

The particular technologies available for our collaboration were bar code scanner, bicycle, compact disc player and burner, facsimile (FAX) machine and scanner, electric and acoustic guitar, Internet search engine(as virtual devices), internal combustion engine, video camera and digital camera, photocopy machine, satellite TV, optical fibers for communication and medicine, and water purifiers

The present paper reviews our pilot year experiences, including

- (1) description of existing (non-engineering) course modification to allow inclusion of device use and dissection for enhancement of course objectives,
- (2) choice of lab devices (from our menu of twelve) to match the cultures and content of each course,
- (3) arrangement of teaching manpower to allow provision for student lab assistants, and
- (4) assessment and evaluation of these cross-college experiments,

Our four year NSF grant allows pilot and final offering of eight different courses from three colleges outside of engineering: CHASS, Education, and Design. We report in this paper our experiences with foreign languages and design in Fall 2004. The full report for spring 2005 collaborations with education will be presented subsequently.

Introduction

Ten years ago, the College of Engineering created a Product and Process Engineering Laboratory, within which engineering students could deepen their understanding, and satisfy their curiosity, by taking apart and re-assembling devices from their everyday lives. Early examples were light-driven devices including bar code scanners, CD players, FAX machines, and video cameras. Subsequent disciplinary expansions included electric and acoustic guitars, internal combustion engines, and cell phones. All participants in this elective engineering lab, from undergraduate enrollees, junior-senior lab assistants, and graduate student authors of individual device chapters indicated election of the lab because it offered opportunity for understanding via device use, dissection and assembly, experiences which they had found woefully lacking in their engineering education. Student understanding was deepened through the reading of a technical device description, carrying out use and assembly exercises, solving of several simple math problems to characterize device performance, and giving group oral presentations to the entire class.

The paths to enhancement of learning objectives realized through such a “hands-on” laboratory are several:

Mechanical manipulation fixes mental images of devices structure and operation, greatly reinforcing and expanding knowledge obtained from the more distant verbal and diagrammatic representations of the device.

Dissection is a process of discovery, in which the “peeling of the onion” reveals successively deeper principles of operation, so that the “black box” nature of many devices becomes translucent, and, finally, transparent.

Exploration of the device is driven by curiosity, and curiosity is rewarded here, rather than punished by the parental or instructor’s classic “Don’t touch that” remark.

In summary, device dissection at all levels renders forms and functions apparent, illustrates clear application of general laws of nature to particular design challenges, and rewards curiosity. The typical separation between academia and the outside world vanishes: the student holds, dissects, and assembles an everyday reality for which the coupling of device operation to elementary principles of physics, engineering and material science is ever present, yet without artificial or forced linkages.

The present paper reports a teaching experience in which such device dissections in an engineering lab are utilized to enhance the learning objectives and student satisfaction in four courses in non-engineering colleges: the Colleges of Humanities and Social Sciences, Education, and Design.

Engineering Laboratory Description

Unfortunately, US engineering schools generally provide no unrestricted laboratory courses suitable for a broad range of majors, in contrast to our sister scientific disciplines of physics, chemistry, and biology. This paper attempts redress of that lack, through the utilization of our engineering device laboratory to provide cross-college collaborations through co-teaching or supplementation of existing courses taught in three NCSU colleges: Colleges of Humanities and Social Sciences (CHASS), Education and Psychology (CEP), and Design. The collective set of students to be impacted includes (i) engineers in foreign language courses, (ii) pre-service technology education students seeking K-12 teaching degrees, (iii) in-service technology education for practicing K-12 teachers, and (iv) industrial design majors.

We envisioned that the lab would function by analogy to other campus service labs such as computer workstation centers and chemical instrumentation/analytical labs. Thus, the engineering instructor (Ollis) provided a list of available devices to each participating instructor (Kennedy(Languages), Laffitte(Design), and Peterson and DeLuca (Education), and these “users” then selected those devices thought most pertinent or applicable to their courses. This paper presents our first experiences with this novel format of providing lab modules for courses in other colleges of our university.

We expect that our collaboration format may transfer easily to other campuses. Every campus has a college of humanities and social sciences: we here demonstrate utility of technology lab modules to enhance language learning through the (engineering) discipline. The need for “Technology Literacy” for K-12 teachers is relentless: we here demonstrate cost-effective inclusion of modern technologies in pre-service undergraduate and in continuing education for MS students. Industrial Design is concerned with creative development of products people use; we demonstrate inclusion of engineering lab devices for our industrial design students junior studio. In combination, these examples indicate the broad flexibility which an engineering laboratory can provide to enhance achievement of student learning objectives in other colleges.

Pilot Year Accomplishments in Cross Campus Collaborations

For the language and design course collaborations, first offered in Fall 2004, we describe the original format, the modification made to utilize lab device modules, and an initial assessment of lab module effectiveness in enhancing learning objectives. The education courses joint ventures will be offered in spring 2005, and reported at a subsequent ASEE meeting.

Fall 2004

College of Humanities and Social Sciences : “Spanish: Language, Culture and Technology”

Original format

Because one quarter of our NCSU students major in engineering, the Department of Foreign Languages and Literatures created a content-based Spanish course targeted specifically at these students, described below:

“The successful execution of content-based instruction in foreign language provides a model for many forms of more vibrant and effective foreign language instruction using a cross-disciplinary approach. This is not simply a conventional language course with specialized vocabulary grafted onto it; rather it represents a new way of teaching, an interdisciplinary approach, utilizing faculty and resources from both engineering and foreign languages, that will provide an enhanced and exciting educational cultural experience. It will ultimately help students to communicate about their professional work in a larger global and technological context. (NCSU Course justification statement, FLS 212, <http://courses.ncsu.edu/hon.html>)

The students will learn vocabulary commonly used in technology context and will develop the ability to comprehend and use Spanish in professional settings. They will also develop an awareness and appreciation of Hispanic culture, including the cultural and historical importance of artifacts in the Hispanic world. As a result, in addition to mastery of the intermediate language curriculum with emphasis on speaking, reading, and writing in Spanish, students will learn to appreciate cultural awareness as a practical tool in the application of their engineering training to specific projects in their professional careers.” (NCSU Course Objectives statement, FLS 212, <http://courses.ncsu.edu/hon.html>)

Course Content

FLS 212 utilizes not only teach the structure inherent in an intermediate language class by integrating vocabulary, issues, and projects that would be of special interest to the technical student, but also integrates cultural and technical issues in our global society. The object is to enlist the student’s enthusiasm for technology in the process of learning a foreign language and studying international cultural and technological issues. In our global society, our students are acutely aware already of the professional value of the ability not only to speak a foreign language but to have a working knowledge of the technical language of their chosen profession.

What we want our students to learn: (*italics indicate learning objectives directly related to lab component*)

- Students will master grammatical structures required in an intermediate Spanish class
- Students will communicate with newly learned structures in written and oral form
- *Students will learn vocabulary commonly used in engineering and technology contexts*

- *Students will develop the ability to comprehend and use Spanish in settings invariably encountered in our technological society*
- *Students will demonstrate an awareness and appreciation of target culture; will demonstrate understanding of guides to cultural and engineering sites and artifacts; will demonstrate an understanding of cultural and historic artifacts in the Hispanic world: Roman aqueducts, pyramids, castles, cathedrals and basic principles of architecture*
- *Students will interact in a more formal setting such as the presentation of a technological/cultural project to class and guests*

This intermediate course enlists the expected review of grammar and vocabulary in the service of teaching the language and concepts of technology in global context. With a non-engineer teaching the language, a two hour bi-weekly “take-apart” lab is added in which students study the cultural importance of devices such as bicycles and guitars, read technical materials in Spanish, keep a notebook with labeled diagrams in Spanish and prepare an oral and written report to teach us what they have learned from the lab. To stress the importance of their hard and innovative work, Dean’s staff from the College of Engineering is invited to our final presentations.

The original lecture course, Spanish: Language, Culture, and Technology, was already “engineer friendly”, having been created to serve this student group. Thus, in addition to the integration of technology topics into cultural and language contextx, the course involved substantial use of wireless laptops, and included reference to web-based materials such as Marshall Brains’s “HowStuffWorks.com” website. Details of these activities in the original format are reported in a companion paper at this ASEE meeting (Kennedy, Ollis, and Brent (2005)).

Course modification via cross college collaboration

We adopted this “take apart” lab of consumer electronic and household devices to teach young engineers this vocabulary and modes of thought of their profession in Spanish and demonstrate it to be an effective teaching tool in the class: Spanish: Language, Technology, and culture”

Following the format of the product and process laboratory for engineering students, 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 program and also expanded their Spanish engineering vocabulary and developed their presentation skills in a language that is in fact becoming a necessity in our global community

Each lab has material -specific guidelines for that particular lab and report to class, notebook completion, oral presentation and demonstration to class. Here are some general guidelines for all of us:

The in-class group oral presentation (in Spanish) comprised:

- 10 bulleted points on history of device and other introductory material
- 20 important vocabulary words in Spanish that all engineers should know
- Description of purpose of lab, procedures, conclusions
- Graphics: important diagrams of lab work
- Show and tell: tools, parts, functioning of parts- in short, any demonstration that may help us to understand machine better
- Calculations: choose 3 problems and explain calculations and significance of problem

Written work to be handed in the day of oral presentation- all members of group

- Notebook with diagrams and procedures- in Spanish if possible
- Calculations
- Short essay on cultural importance of this technology: how technology reflects time, place, and people

Students were encouraged to be creative in demonstrations and graphics presentations. Vocabulary explanations and handouts were always helpful. Power Point software was used widely.

Each student is expected to follow the work in the take-apart lab with these assessment instruments: a lab notebook, an oral presentation, and a short paper. The students maintain a lab notebook which describes the historical and cultural significance of their device. Included in the notebook is a vocabulary list in Spanish of at least 20 technological words, diagram of the components of the device in Spanish, and three calculations given in the written materials for each device.

Lab reading

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

The language instructor modified these materials in the following ways: First, she translated a few pages of introduction and history of the device. The initial lab steps were also converted to Spanish, including instructions on taking device apart. The last few labs were in English so the students could work from Spanish-English or English to Spanish. There were 4 activity labs and three calculations.

For the oral presentation, students described the lab process explain the cultural importance of their device, import vocabulary which the whole class should know, and perform one calculation that was a part of the lab.

Evaluation and Assessment

Evaluation and assessment activities were of two kinds: a written questionnaire to the students, addressing specifically the instructor’s student learning objectives for the course, and in depth interviews by Dr. Rebecca Brent, conducted with focus groups (students and TAs) and individual faculty (Drs. Kennedy and Ollis).

The student questionnaire results appear in Table 1, and those for the oral interviews in Table 2.

Table 1

Summary of Student Survey

“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 six objectives relate directly to the laboratory experience, and associated class reports. Please indicate your judgment as to the following objectives:

Learning Objective: (below)	Hypothesis: The laboratory component contributed to achievement of this learning objective:			
Students will:	AGREE STRONGLY	AGREE	NEUTRAL	DISAGREE
Learn vocabulary commonly used 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,	8	4	2	1

castles, paintings, and basic principles of architecture

Interact in a more formal setting such as presentation of an engineering project

5	9	1	0
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These initial results demonstrate that students believed the integration of a laboratory experience, including class discussions, website reporting, and oral and written presentations, provided a clear enhancement to achievement of the instructor's 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, and included two sets of student participants: the enrolled students and the lab assistants. Summaries of student comments appear below from each set of interviews.

Table 2

Summary of focus Group Interviews: Spanish for Engineers

Student Focus Group

Things that worked to help them learn:

- Dr. Kennedy as a teacher (there were lots of positive comments about every aspect of her personality and teaching style)
- Learning Spanish vocabulary in the take-apart lab
- Being able to work at their own pace with their group
- Seeing how culture and technology are related
- Learning from the native speakers about the language and culture they are a part of

Challenges and barriers to their learning:

- Finding a time for the lab (June 2004 NSF funding meant that labs were added after closure of the formal fall semester schedules)
- Not knowing what to do in the beginning of the lab
- The different resources in the lab—some groups had many books and weren't sure what they needed to use, others didn't find much useful in the documentation
- Too much time was allocated so some students lost motivation

TA Focus Group

Things that worked for the students:

- Learning the Spanish vocabulary in the take-apart lab

Suggestions or changes they would recommend:

- Provide the TA's with more orientation. to help define formal role.
- Students didn't need as much time in the lab. Either shorten the lab or have each group take-apart two devices.
- Add peer evaluation and assessment of learning in the lab.

The interviews provided good opportunities for suggestions for lab improvements. Learning a language in a laboratory context, and having time to take apart devices and tinker were clearly valuable aspects. Comments regarding lab time and TA duties may be related: the dominant enrolled groups were engineering seniors, who likely had no need for lab assistants as instructors. Next year, we will have all students scheduled into common lab hours, and expect the lab instructions to be entirely self-paced. The (fewer) lab assistants will have primarily a lab maintenance role. Also, the lab instructor (Ollis) will provide a more formal introduction to the lab, on-site and/or in class. Finally, as suggested, the lab time will be shortened, or two devices will be incorporated into the course schedule. The course student questionnaire will be extended to invite suggestions for improvement.

Programs such as this one cannot help to better equip our engineers to go out and compete in the global economy. This model can be used in other language classes with Engineers and we might expand these exercises to include French, Portuguese, and Arabic.

Fall 2004 College of Design: Industrial Design

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, to 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.

In recent years, the myriad new technologies used in products have presented a particular challenge to design educators, because of the high level of scientific and engineering based knowledge needed in order to understand the technology for the sake of applying it creatively. Whereas in the past the typical student applicant to an industrial design program often had a long history of taking apart their toys and later, fixing their cars, the advent of both 'Nintendo' and fuel-injection has created a 'black box' syndrome among incoming students. Although there are a few particularly gifted students who rose to the occasion and learned to 'hack' their way into the hermetically sealed objects of their youth, and can now function well in both the design school and the engineering lab, most educators find this a difficult gap to bridge. Within the Design College, this

situation has tended to result in student projects that fall short of achieving maximum results in terms of products technical aspect. There are also instances where the technical concept of a student's project may be possible, or even innovative, but it is difficult to confirm this with certainty.

The present NSF-sponsored development allows initiation of a design pattern similar to that which is emerging in industry, that of overcoming complexity by the use of a multidisciplinary team approach.

Course description: Design Studio

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 the 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 the 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.

Another outcome expected in all studio courses is that the students, especially at the outset of a project, develop their ability to conceptualize a broad number of potential solutions in confronting a design problem, rather than relying on the first or most obvious approach. In addition, the students are required to demonstrate the validity of their design process at any point during the development cycle, not just in the final review of the completed project. It is this requirement that keeps the students from falling into a pattern of relying on a last minute 'miracle', and promotes the discipline of channeling and refining their creative ability into a professional tool.

The measure of these collective outcomes is evidenced in the student's portfolio. All students begin developing their portfolios in their first semester of freshman year, displaying both the end results and the process by which they achieved those results for each of their major studio projects.

The studio courses are sequentially arranged throughout the eight semesters of the four- year of undergraduate program, with the projects becoming progressively more challenging each year. The fall semester, Junior Studio was chosen for the pilot test of the new *Product Technology Course*, because during the sophomore year, students complete two 3 credit hour service 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 projects. This studio therefore seemed a good place to include course content related to the technology embedded in the product itself.

Course modification via Cross-College Collaboration

The new course was to begin by assigning 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 they understood the existing product and it's 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 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 they 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 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 the 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, disproven, 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 graduate students 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 the students, and made them more willing to explore the overlapping interests between the College of Design and the College of Engineering. We have observed 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 other disciplines 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.

Unexpected benefits: creative design for engineering students

As Department Chair of Industrial Design, Prof. Laffitte meets with several students each semester who come to his office wanting to transfer out of an engineering program and into industrial design. They typically indicate that the engineering curriculum is not offering them enough opportunity for hands-on, creative application of the information they are learning. Some of these students possess the visual and spatial ability, and sketching skills to succeed in industrial design. Those who gain admission often become some of our most outstanding design students, able to creatively apply a range of complex technologies. It is not unusual for them to mix the engineer's strengths in areas like CNC machining, the design of printed circuit boards, specification of stepper motors and power supplies, and competence at programming, with the designer's innovative approach to problem-solving, creativity, and aesthetic ability. Those who remain in engineering have a novel possibility suggested here, that of serving as a lab assistant and joining an industrial design group for a semester. We will explore the academic possibilities for credit activities next year in this regard.

Relevance: Cross-college collaboration addresses ID challenges and needs

Changes in global economic forces are having a profound effect on the industrial design profession, and on all of the industries that it serves. The State of North Carolina has, over the past ten years, suffered overwhelming job loss in both the textile and furniture manufacturing industry, in the aftermath of loosened international trade restrictions. Across the country as a whole, jobs in manufacturing have eroded under the pressure of offshore competition from Asia, India, and China. More recently, 'offshoring' has begun to occur in design offices as well, and has also begun to affect such fields as engineering, architecture, and computer programming. The implication is that the 'low hanging fruit' of low-tech, commodity product design is gone, and that in order to remain competitive the profession must focus on collaborative innovation on 'high-tech' products, based on cutting edge university research, because these products are difficult to replicate by low cost labor strategies.

Assessment and evaluation

This studio section (one of three offered) of the junior year *Studio* involved nine Industrial Design students, a atypical section size.. Each was interviewed individually by Dr. Rebecca Brent at semester's end. Taken together, Table 3 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.

Table 3

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 problem, given a device.(i.e., no customer or safety or aesthetic complaint given)
Devices were often older devices, not cutting edge.

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.
The second device (post mid-semester) activity was not well scheduled (not synchronous among ID students). Not enough time for some to do well.
Would have liked to see a woman lab assistant (ID enrollment is about 40% female).

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 note: opportunity to use, dissect and work directly with commercial devices, and the realization of cross-college collaboration of students (not just instructors). Opportunities for improvement include installation of updated products in the lab (design must be "cutting edge") and where possible a synchronization in starting the second half of the semester. From earlier design instructor comments, and from the student feedback via interviews, we conclude that the device laboratory clearly provided an enhancement of learning opportunities, as hypothesized in our original proposal.

The two engineering lab assistants were also interviewed, and their comments are summarized in Table 4 below.

Table 4

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 be answered more quickly (initial hour each period would be OK).
Students would be more excited if they could take 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.

The conclusions and recommendations of the three authors are summarized in Table 5 below.

Table 5

Evaluator Recommendations and Instructor Plans Forward

Evaluator (Brent) recommendations

Acquire some up-to-date devices that are closer to “cutting edge” (e.g., MP3 player, digital voice recorder) and some that might hold interest for different learners, especially women (e.g., child safety seats, mechanical toys, motorized kitchen appliances)

Have a mechanism for checking out devices to take back to the studio

Decrease the first week time (9 hours) in the lab, and allow for a later return if needed

Have the lab assistants at the ID studio at least twice per week (full 3 hr session not needed; just a 1 hour presence to “check in” for technical questions.

Instructor plans forward (Laffitte and Ollis)

Adopt above recommendations where possible budgetarily.

Provide formal introductory demonstration of device dissection, with ID students dissecting the same device in parallel.

Use periodicals (*Wired* and *ID Magazine*, as well as web pages (gadgets.com) to keep choice of lab devices more current.

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Author biosketches

Ana Kennedy is a faculty member at NC State where she has taught for 14 years. She also serves as the coordinator of advising for the Dept. of Foreign Languages. She received her Ph.D. from Duke University in Spanish Golden Age Literature. Her areas of research include pedagogy, golden age literature, and student services,

Bryan Laffitte is Head, Industrial Design, and Associate Professor in the College of Design of North Carolina State University.

David Ollis is Distinguished Professor of Chemical Engineering at NCSU. He has recently co-edited (with Kay Neeley, University of Virginia and Heinz Luegenbiehl, Rose-Hulman) the text “Liberal Education in Twenty-First Century Engineering,” Peter Lang, publisher, New York, NY 2004

Dr. Rebecca Brent is founder of Education Design, Inc, in Cary NC. She has taught in the College of Education at Eastern Carolina University prior to moving to Cary, where she has authored numerous engineering education publications with her husband, Richard Felder (NCSU professor emeritus)..