Installing a "Technology Literacy" Course: Trials and Tribulations

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Abstract

The creation of a new technology literacy course for non-technical students is described. The author, an experienced engineering faculty member, describes his sojourn through several less-than-familiar landscapes, including the regions of "finding funding" for this non-traditional subject, "and navigating the bureaucracy" of course authorization on his campus.

1. Introduction

The author created, in 1992, a device dissection laboratory for incoming first year engineering students. As "It seemed desirable to base a new lab on some modern and emerging technologies", the course was developed around six light-based devices: bar code scanner, compact disc player, optical fiber communications and probes, photocopier, video camera (and VCR recorder), and ultraviolet (UV) light driven water purification.[1,2] This inexpensive lab was assembled for less than $3,000, and has been utilized in the following formats over a ten year period:

(1) two week summer camp[1,2] (1993-1994) (NSF-SUCCEED)
(2) semester length "device dissection" lab[3,4] (1995-1996)
(3) in combination with an English writing course[3]
(4) (part of) summer minority eng'g. orientation (40 students)[3,4]
(5) six hour/semester (1 device) experience for all 1,100 entering engineering freshmen.[5]

All student clientele for these lab versions were incoming or first year engineering students, and the switch from one lab format to another was accomplished with minimal reorganizational effort.

Expansion of lab concept to yet other educational opportunities arose naturally, as summarized in "A Lab for all Seasons, A Lab for all Reasons" (ASEE 2000, Ollis).[6] One

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such possibility included "Technology Literacy", a course aimed at non-technical majors. The origin of the author's efforts here is John Krupczak's "Technology Literacy" course developed by this physicist for students at Hope College, a small, selective admission college with a dominance of liberal arts majors[7-10]. The present author's pathway to establishing this latter course for non-technical majors at NCSU has been anything but smooth, in contrast to the earlier course incarnations of "device dissection" for technical majors cited above. The present paper reports the bumpy road, lessons learned, and current status of installing technology literacy at NCSU, in hopes that it may assist other interested faculty in initiating similar ventures.

2. Background

Nan Byars of the University of North Carolina-Charlotte, concisely summarized the history of technology literacy in undergraduate education, including the following achievements:[11]

– "In the late 1960s and early 1970s, engineering educators at a number of American colleges began to offer courses for non-majors"
– During the 1980s, the New Liberal Arts program of the Alfred P. Sloan Foundation helped lay the foundation for engineering-based TLCs (technology literacy courses) through the creation of textbooks and other course materials, led by professor John Truxal of "SUNY Stony Brook."
– TLC programs with an engineering emphasis are now established at multiple universities including "SUNY-Stony Brook, Stanford, Penn State, MIT, Dartmouth and Lehigh," and new efforts have appeared at Miami of Ohio, Lake Superior University, University of Dayton, UNC-Charlotte.
– 1997 NSF-initiated funding at UC-Irvine, Univ. Colorado-Boulder, Univ. of Maine-Orono, Middlesex County College (NJ), Franklin Pierce College (NH), and Dartmouth College (NH).

The drum beat to develop Technology Literacy has been constant over the last decade. A recent restatement is found in Technically Speaking, Why All Americans Need to Know More About Technology, National Academy of Engineering (2002).[12] The still youthful nature of technology literacy development is indicated in the opening preface:

"The idea that all Americans should be better prepared to navigate our highly technological world has been advocated by many individuals and groups for years. Nevertheless, the issue of technology literacy is virtually invisible on the national agenda. This is especially disturbing in a time when technology is a dominant force in society. By presenting the topic in a straightforward and compelling manner, the committee hopes technology literacy will be put "on the map" and the way will be cleared for a meaningful movement towards technology literacy in the United States."[12]

3. Finding Funding for "Technology Literacy"

John Krupczak reported in 1996-1997 on the development of his successful technology literacy course at Hope College.[7,8] His topics included the following: automobiles, electrical and magnetic devices, light and electromagnetic waves, telecommunications, audio equipment and computers. In each case, the underlying physics of the device was explained in lecture, a lecturer lab demonstration was included, and the students constructed inexpensive, take-home devices which illustrated key features of each device.

Given our prior development of a Product and Process Engineering Laboratory, the use of the lab devices as part of a new Technology Literacy course for NC State seemed a straightforward proposal, to be achieved by obtaining funding for development, then course piloting and evaluation, followed by institutionalization.

A 1998 NSF electronic bulletin from its Division of Undergraduate Education (D.U.E.) program in Courses, Curriculum and Lab Improvement invited Adaptation and Implementation (CCLI-A/I) and appeared to be ideal: adapt a course developed elsewhere and implement a local campus version. So we proposed to adopt Krupczak's integrated lecture and "hands-on" format, adapt our (then) current lab-only "device dissection" experiments to a lecture-lab format, and run pilot versions for a 2-3 year period.

My first NSF proposal to D.U.E. was wonderfully naïve. In brief, it said I would integrate Krupczak's course format with our existing lab to create a "light-driven device" technology literacy course, and the students would come. The review as of my initial proposal were uniformly unconvinced, as evidenced by their comments appearing in the NSF Panel Summary:

(1) "As a modification of an existing course, it is not clear that additional funding should be requested at this time. Should not the PI make this course accessible to non-engineering majors because it's the right thing to do, without additional support."

(2) "The PI indicates that he has talked with some consultants to help to develop the new material, but their input into this course is in evaluating, not planning. A better integration of the consultants into the development plan should be included."

(3) "The proposal is a good start towards developing a means of providing a technical education for non-engineers but it is weak on implementation."

(4) "We are concerned that students will not learn much about engineering".

(5) "This course doesn't build anything — what references do they leave the class with, how will they teach themselves in the future."

(6) "There is some concern that this will be a course without an audience. There is no indication that students would want to enroll, and no plan on how to attract non-engineering students."

(7) "In the words of the old Wendy's commercial, "Where's the beef?" It's not there. The PI should put some greater thought into what he wishes to teach the non-technical student, decide how best to do this, and then proceed."

My original proposal clearly failed to provide an attractive case. A second proposal one year later responded explicitly to all seven key critiques:

(1) Funding requested was needed to develop lectures and re-write lab manual.
(2) Consultants John Krupczak and Nan Byars were included to critique course materials and syllabus as well as student outcomes.
(3) Course Implementation was clearly indicated via lecture topic sequence, and use of senior undergraduate engineers as lab TAs.
(4) Students would receive an opening lecture on engineering as "Design under constraints" to illustrate the engineering method. W. Wulf, National Academy of Engineering.
(6) Re-assembly of existing lab devices was emphasized as a form of building.
(6) A student recruitment recipe was made explicit (advertisements, flyers to faculty and undergraduate advisers)
(7) "Where's the beef?" Preceding responses (1) – (6) addressed this overall concern.

The year 1999, second submission, reviewed in year 2000, was also declined. Proposal reviews were much more favorable, but a new criticism apparently proved fatal: The proposal course did not have a clear statement of learning objectives, and thus the proposed evaluation and assessment was lacking a convincing basis.

A resubmission for that following year, 2001, did not occur due to a summer 2000 medical event: the unplanned need to replace a principal investigator's heart valve!

The third proposal attempt revisited Nan Byars' survey: "Technology Literacy Classes: The State of the Art".[12] Specifically, Byars' four point definition of technology literacy was utilized to provide explicit items for evaluation and assessment as well:

"Technology Literacy: A Working Definition"[12]

"The ability to understand, intelligently discuss and appropriately use concepts, procedures and terminology fundamental to the work of (and typically taken for granted by) professional engineers, scientists, and technicians; and being able to apply this ability to:

(i) critically analyze how technology, culture and environment interact and influence one another.
(ii) accurately explain (in non-technical terms) scientific and mathematical principles which form the bases of important technologies
(iii) describes and, when appropriate, use the design and research methods of engineers and technologists

(iv) continue learning about technologies, and meaningfully participate in the evaluation and improvement of existing technologies and the creation of new technologies."[12]

The resulting third submission was awarded a three year grant, to begin in May 2002. All that was needed now to submit a "New Course" proposal to the internal NCSU committees, and we would be on our way!

4. Trailblazing "Technology Literacy" as a new course

Excepting our device dissection lab (Engineering 123), the NCSU College of Engineering has virtually no experience in creating new courses with a college, rather than departmental, designation. Moreover, the college has no experience in offering service courses to NCSU undergraduates. Thus, no prior model existed for the development of a new lecture-lab format in technology literacy. Nor were there existing administrative connections to promote cross-college development of such a service course. Our path to receipt of approval to offer a new course was thus not straightforward, as we failed to anticipate.

a. Submission as a full, new NCSU course was received and accepted by the College of Engineering Committee on Courses and Curriculum (CCC) and passed on to the University level.

b. The University committee secretary sent the package back, indicating that it lacked substantial, required details (explicit reading assignments, evidence of consultation with other departments, etc.) and suggesting that the "trial" version be offered through a departmental "shell course" listing, created explicitly for new course trials.

c. The P.I. department did not have a "shell" course listing, at the first-second year level, so the COE (CCC) suggested a pilot offering exclusively for our undergraduate University Scholars program which regularly solicits new "honors" course developments. A survey of that group found that the modest number of non-technical majors at our widely technical land grant campus would likely be insufficient to provide adequate course enrollment, so this approach was dropped.

d. Finally, in fall 2003, the PI and the College of Engineering petitioned the Electrical and Computer Engineering Department for permission to use their "shell course" number, ECE 297T, as the descriptor for the new course, to be piloted in the spring 2004 semester. The petition was accepted.

5. Identifying the NCSU student audience and motivation

All NCSU undergraduates must fulfill course distribution requirements for their degrees. Undergraduates in our Colleges of Humanities and Social Sciences (CHASS), Art and Design (ADN), Education, and Management are required to take a three unit course in Science, Technology, and Society (STS), selected from the Science and Technology track of the authorized STS electives. No elective in this current list is focussed on explaining to non-technical majors the workings or technical origins of modern technologies. The NCSU Undergraduate catalog 2001-2002 thus indicates the the proposed course could help to fulfill the 3 unit STS requirement (science and technology track) for non-technical students majoring in CHASS (B.A., B.S.), Education (Business and Marketing), Technology Education, Management (Accounting, Economics), and Architecture, (Art and Design, Graphic Design), and Industrial Design. These student groups were clearly our target audience.

6. Re-Stating the student learning objectives

To rephrase Byars' technology literacy compounds in terms more responsive to our NCSU undergraduate distribution requirements, the following statement appears in our current new course description:

"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) Develop an 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.
(4) Develop an understanding of the impacts (technical, economic) of a device in a given context, through lecture, lab, and individual analytic written papers.

7. Recruiting the students

Student recruitment required both a syllabus which is attractive and an appropriate advertising campaign. The latter involved distribution of syllabus copies to faculty in the appropriate colleges, and advertising the new course in the local student newspaper. The advertising examples appearing below was published for several weeks in the NCSU student newspaper, Technician, and resulted in achievement of a modest, but insufficient initial enrollment.

ADVERTISEMENT

NEW COURSE SPRING 2004
for students in
CHASS, ART & DESIGN and ED & PSYCH
TECHNOLOGY LITERACY
For Non-Technical Majors

Learn about the evolution and working principles of your favorite device:
electric and acoustic guitar, CD and DVD "burners", bar code scanners,
photocopy machines, digital cameras, optical fiber communications, Internet, engines,
computers, and water purifiers (3 units) Open: soph, jr, & sr TRACS LISTING: ECE

292T 001 SPTP-TECH NON-MAJR call no: 334580 M W 0130-0220 PM Instructor: D. F. Ollis (TWO-HOUR DEMO LAB, WED 2:30-4:30) QUESTIONS call 5-2329

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, a first class titled “Electricity to work: from Franklin to electric power”, and a second period titled “Electric motors”. The complete lecture topic sequence appears in Table 1 below.

Table 1: Lecture topics

TECHNOLOGY LITERACY

EVOLUTIONARY CONTEXT	MODERN EXAMPLE
Introduction to technology	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 electrification
Exchanging electrons for information: telegraph, Satellites, telephones, and cellular phones	Cellular phone networks and
Catching the light: from Archimides to optical fibers	Optical fiber systems
Coding of languages: from the Rosetta Stone	Internet search engines
Tracking materials in commerce: from barter to bar codes	Bar code systems in commerce
Producing sound: from Galileo to Grunge	Acoustic and electric guitars:
Recording images: from Niepce to digital cameras	Digital cameras
Recording sound: piano rolls to discs	CD “burners”
Reproducing information: from Gutenberg’s photocopy and scanner machines	Black/white and color press to photocopy
Making new materials: from ceramic alchemy To semiconductor science	The semiconductor chip
Safe water in civilization and commerce: From Roman aqueducts to ultrapure water	Ultrapure water

The two-hour “lab” per week period will be used to accommodate two needs: provision of (i) adequate hands-on experience in device dissection and assembly, and (ii) sufficient time to read, organize, and write two short papers on the evolution, workings, and impact of a particular technology not covered in class or laboratory. The schedule for such a lab/paper sequence appears in Table 2.

Table 2

Technology Literacy: Historical Context and Technical Concepts
Laboratory and Term Paper Calendar

Week	Activity
1.	**READ** lab chapter, explore lab, set rules and team responsibilities
2.	**USE** fully operations device (all team members, most/all of device functions)
3.	**DISSECT/ASSEMBLE** device (find/report operating principles, paths for flows of light, paper, tape, information, etc)
4.	**CALCULATE** device characteristics and performance
5.	**DESIGN**: conceive, sketch, estimate performance of a next generation device
6.	**PRACTICE**: lab team oral presentation
7.	**TEAM PRESENTATIONS** to class
	PAPER ASSIGNMENTS:
8.	**PAPER 1:** Choose a new device, read history of technical development, library search, write paper describing device operation
9.	**PAPER 1:** Outline due
10.	**PAPER 1:** 5 page paper DUE
11.	**PAPER 1:** Choose a device not covered in lab or lecture; read, research as above, write paper describing both operation and technical and economic impact.
12.	**PAPER 2:** Outline due
13.	**PAPER 2:** COMPOSE, SUBMIT DRAFT (returned with comments)
14.	**PAPER 2:** 10 page paper FINAL VERSION due
15.	**POSTER PRESENTATIONS (PAPER 1 OR PAPER 2) (in final exam time slot)**

In summary, after initial, repeated failures to find course funding, and then to receive internal authorization to offer such a course, we have achieved both. Ultimately, patience and persistence were rewarded. The new course is not being piloted in Spring semester of 2004 but will need to be sold this spring to administration and faculty in the Colleges of Humanities and Social Sciences, Education, Management, and Architecture.

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9. Biographical Information

David F. Ollis is Distinguished Professor of Chemical Engineering at North Carolina State University. He has recently edited, with K. Neeley (University of Virginia) and H. Luegenbiehl (Rose-Hulman Institute) Liberal Education in Twenty-First Century Engineering: Responses to ABET/EC2000, Peter Lang Publishers, New York, N.Y., 2004.