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Integrating Humanities and Engineering Technology Education in the Classroom: A Model Course

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Abstract

Historically, humanities education in engineering technology curricula has been governed by accreditation requirements. Students are required to take a certain number of hours of humanities and social science classes, which are generally not integrated with the rest of the curriculum.

In light of the ABET 2000 accreditation criteria, which focus on outcomes rather than on specific course requirements, and based on our earlier experience with integrated classes, we developed a course that combines instruction in both history and materials science. Titled "Steel and the Industrial Revolution," the course was offered in the Winter of 2001.

The class served as both an introduction to materials science for Mechanical and Manufacturing Engineering students and as an introductory course in the history of the Industrial Revolution. Classroom instruction was a seamless blend of material from both disciplines, with both instructors in the classroom at all times and combined homework and examination assignments.

This paper describes the development of the course, its advantages and disadvantages, and our plans to use what we learned to offer similar courses in the future.

I. Introduction

Humanities instruction for engineering technology students at the Oregon Institute of Technology (OIT) has in general been similar to that offered at most other engineering technology schools: a set of separate courses not integrated into the curriculum as a whole. While OIT, much like other engineering technology schools, offers a number of courses in the history of technology, Science, Technology and Society (STS), and professional ethics, these are not part of the required curriculum and are not linked with technical courses.

For some time we have been dissatisfied with this state of affairs. Recently, we have been inspired by the outcomes-based structure of the ABET 2000 accreditation criteria to experiment with courses linking engineering technology subjects directly with humanities subjects. As reported in a previous paper, we first developed and co-taught an introductory course on modern materials, incorporating both technical and historical material.[1] Based on that experience, we developed the course that is the subject of this paper. Titled "Steel and the Industrial Revolution," this course used fully integrated classroom instruction and homework assignments to teach both basic metallurgy and the history of the industrial revolution.

II. Goals

Based on our prior experience with teaching integrated classes, we set the following goals for our course:

1) linkage of technical and historical material for engineering technology students
2) Improvement of communications skills for all students
3) fully integrating all classroom and laboratory instruction

III. Planning

Planning for our course took into account a number of factors, most notably instructor background and experience, previous experience with integrated courses, the target audience for the course, the overall course structure, and assessment.

Dr. Clark's education and teaching experience is in the history of technology, with a particular focus on the 19th and 20th centuries. Dr. McMurchie's background and teaching experience is in manufacturing engineering technology, with a particular focus on materials science. We had known each other for four years when we began planning the course, and had taught one class together before. Given our interests, we decided that a course that focused on the impact of changes in materials on society over time would allow both of us to play to our strengths.

Since our target audience was students already enrolled in the Mechanical Engineering Technology and Manufacturing Engineering Technology programs, we decided to use existing courses as the basis for the combined course. This allowed us to avoid the complicated process of getting approval for a new course number and adding it to the course catalog and engineering curriculum. In the future, we plan to offer the course under one course number. A copy of the course syllabus is attached as Appendix 1.

Students were required to co-enroll in MET 160, a required materials science class for both mechanical and manufacturing students, and HIST 225, a humanities elective class covering the history of the industrial revolution. The combined class met for five lecture hours and three laboratory hours each week, for a total of six credit hours.

The combined class was open to both engineering and non-engineering students. Eighteen students enrolled, all from engineering technology programs.

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[1] Mark Clark and Donald McMurchie, "Integrating Humanities and Engineering Technology Education in the Classroom: A Case Study," Session 3650, Proceedings of the 2001 ASEE Annual Conference & Exposition.

Building on our previous successful experience with combined classes, we decided to use again what we consider our most successful innovation: full integration of technology and humanities instruction. As in our previous class, we planned for both of us to be present in the classroom for all lecture sessions. We also planned our examinations so that they combined both technological and historical concepts.

In order to assist students in developing written communications skills, all examinations were planned for an essay format, with extensive feedback to students to allow them to improve the quality of their work.

To assess the strengths and failures of the class, we decided to give all students an initial inventory questionnaire, and both a mid-term and exit assessment of student satisfaction. During the course of the term we decided to add a focus-group discussion with all students during the ninth week to obtain additional feedback.

IV. Implementation

After obtaining permission to offer the course from our administration, we both recruited students. We found it was essential to reach out to students and explain to them personally what the class was about, since it was unlike others previously taught at our institution.

Our plan to teach cooperatively worked out well. We typically alternated lecture presentations in short segments (five to ten minutes), or engaged one another in Socratic question and answer dialogues. We both answered student questions and conducted discussions.

Examinations were conventional, but oriented towards written expression to help students develop their communications skills. Regular written assignments on assigned readings constituted the homework portion of the class, and a mid-term and final examination (both take-home essays) the major test instruments.

V. Results

The course was evaluated using three methods. First, we compared the performance on oral and written assignments of students in this class with students in previous, non-integrated sections of the same course. Second, we surveyed all students using a variety of instruments. Finally, we performed a self-assessment after the conclusion of the course, comparing our experience with the goals we had set for the course.

From the point of view of the students, the class was very successful. We conducted written surveys at mid-term and just before the final examination, and an open class discussion during the last day of class. Feedback from all three sources indicated that students enjoyed the class a great deal. Students cited three factors that they felt improved the course. First, having two instructors in the classroom, so that material was presented from two perspectives and was thus easier to grasp. Second, that historical materials, particularly the assigned readings, were much more interesting since they were related to technical material discussed in the classroom. Finally, that the variation in presentation style and extensive use of discussion made class more interesting and involving.

A significant majority of students specifically requested that more courses with this structure be taught in the future.

From our point of view as well, the course was also a success. The format made teaching easier, since each of us could rely on the other for help in preparation and lecture delivery. We also enjoyed the higher than normal level of student interest and class participation. We had no trouble getting students to participate, particularly in class discussions, and we developed a positive rapport with everyone.

We also noticed that students did careful and extensive work in their written assignments, and showed a marked increase in the quality of their writing over the course of the class. In particular, students clearly demonstrated that they read both the technical and historical material they were assigned with considerable care and were able to use it in both discussions and examinations.

The only difficulty we experienced was the lack of integration of laboratory exercises with historical material. We were unable to develop a number of planned laboratory exercises, such as a blacksmithing demonstration, due to a lack of time and shortage of resources. We plan to correct this in future offerings of the course.

Overall, formal evaluation of the three objectives noted in section II. Goals above show that all three were met. First, students were able to integrate historical and technical material, based on their performance on written examinations and in class discussion. Second, students showed clear improvement in their written and verbal communications skills, based on comparison with students in other classes taught conventionally. Third, classroom and laboratory presentations were integrated, based on both our own evaluation and student feedback.

VI. Future Plans

Based on our experience with this course, we will teach it again at least once a year in the future. We hope to make it a permanent part of the Manufacturing Engineering Technology and Mechanical Engineering Technology curriculum, but we are still negotiating with other faculty members over how to implement the change.

Our institution is currently exploring a major restructuring of general education requirements. We also hope that courses similar to ours will be integrated into the new curriculum structure.

Appendix 1: Course Syllabus

"Steel and the Industrial Revolution"
MET 160: Materials I
HIST 225: The Industrial Revolution

Survey of materials used in industry and an introduction to the history of technology between 1500 and 1875. The primary focus is on steel metallurgy and the iron and steel industry. Topics include: physical and chemical principles as they relate to structure, properties corrosion and engineering applications; relationship of structure to properties; the economic and social roots of the industrial revolution, the technologies and scientific advances associated with it, and its impact on world civilization. Laboratory instruction is designed to add practical experience to more theoretical lecture material. Course credit is six (6) quarter hours.

Course Objectives

At the completion of this course, students should be able to:

1. List the major classes of steel
2. List and explain the common measurement properties used among various classes of materials
3. List the theories that seek to explain the origins of the Industrial Revolution.
4. Describe the factors associated with the beginnings of the Industrial Revolution in the United States.
5. Define the terms "putting-out system" and "factory system."
6. Describe the relationship of a material's structure to its properties
7. Describe the principles of the design of new materials
8. List at least three social changes associated with the Industrial Revolution.
9. List the factors responsible for the rise of the modern corporation.
10. Describe how the industrial revolution changed American attitudes toward technology.
11. Demonstrate safe lab practices
12. Demonstrate improved communications skills

Textbooks:

Budinski, Engineering Materials Properties and Selection, 6th edition
Ruth Schwartz Cowan, A Social History of American Technology
Smith & Clancey, Major Problems in the History of American Technology
Readings packet on reserve in library

Office Hours:

Dr. Clark: MWF 9:30-10:20 am, and by appointment
Dr. Mc Murchie: MTW 12:30-2:30 pm, and by appointment

Evaluation:

Your grade will be based on you performance on in-class quizzes and writing assignments, lab reports, a lab project, homework, take-home mid-term examinations, and a final examination. You will also have the opportunity to earn extra credit by reading additional material and writing short reports. Some assignments are team-based, requiring collaboration with your student colleagues. Non-attendance will impact not only your own grade, but that of your team members as well.

Make-up tests and quizzes are scheduled at the discretion of the instructor. In most cases, every effort will be made to allow you to demonstrate your skills and knowledge. However, make-ups are not automatic and some activities (lab or field exercises, for example) may be difficult to reschedule.

Examinations will consist primarily of in-class and take-home essay questions - expect a minimum of multiple choice and other formats.

Please consult with us anytime you miss or think you will miss a class. Late assignments will be penalized unless a specific arrangement has been approved by both instructors. Permission must be granted **in advance**, unless an emergency situation occurs. Please do not hesitate to check with us if you have missed class or do not understand some of the material presented - we will be happy to work with you to help you keep up.

To earn extra credit, you may read a book on a topic related to the themes of the course (see us for a list) and write a brief (3-5 page) report on the contents. You may write two reports for extra credit. Reports are due on or before the last day of Dead Week (the last week of classes). No extra credit work will be accepted after that date.

Attendance is mandatory (attendance records will be kept) and is considered essential for success. Material will be presented in lectures that is not covered in the textbook or readings; students will be expected to know that information for examinations.

Your final grade will be calculated using the following formula:

Quizzes and in-class writings	20%
Mid-Terms	40%
Homework	10%
Lab work	10%

Final	20%

Class Schedule

Week 1	The Nature of Technology	Smith, Chapter 1
	Fundamentals of Classification	Budinski, Chapters 1&2
	The Scientific Revolution	Readings packet 1
Week 2	Material Properties and Structure	Budinski, Chapters 1&2
	The Age of Discovery	Cowan, Chapter 1
		Smith, Chapter 2
Week 3	Steel Production	Budinski, Chapter 7
		Cowan, Chapter 3
		Readings Packet 2
Week 4	Heat Treatment of Steel I	Budinski, Chapter 8
	Traditional Production	Cowan, Chapter 2
	The Industrial Revolution	Readings Packet 3
Week 5	Heat treatment of Steel II	Budinski, Chapter 8
	The Transportation Revolution	Cowan, Chapter 5
	Railroads	Readings Packet 4
Week 6	Heat Treatment of Steel III	Budinski, Chapter 8
	The Factory	Cowan, Chapter 4
		Smith, Chapter 4
Week 7	Carbon and Alloy Steels	Budinski, Chapter 9
	The Nature of Work	Smith, Chapter 5
Week 8	Tool Steel	Budinski, chapter 10
	Scientific Management	Smith, Chapter 8
Week 9	Stainless Steel	Budinski, Chapter 12
	Technological Systems	Cowan, Chapter 7
		Readings Packet 5
Week 10	Corrosion	Budinski, Chapter 11
	Technology and Culture	Cowan, Chapter 9
	Conclusion	Readings Packet 6

Readings Packet 1:
- Francis Bacon, excerpts from "Novum Organum" and "New Atlantis"
- Steven Shapin, excerpts from "The Leviathan and the Air Pump"

Readings Packet 2:
- Robert Raymond, excerpts from "Out of the Fiery Furnace"

Readings Packet 3
- Peter Kriedte et. al, "The Origins, the Agrarian Context, and the Conditions in the World Market" from Industrialization before Industrialization
- Peter Mathias, "The Industrial Revolution: Concept and Reality"

Readings Packet 4
- T. C. Barker, "Transport: The Survival of the Old beside the New"

Readings Packet 5
Thomas Hughes, excerpts from Networks of Power
Readings packet 6
Thomas Hughes, excerpts from American Genesis

Appendix 2: Final Examination

1) Describe the factory system, with a particular focus on the United States. Be sure to include a description of the financing, management, and work force of the typical factory, and how they changed over the course of the 19th century.

2) Frederick Taylor has hired you to develop a new cutting tool for use in his machine shop at Midvale Steel. He has asked you to select the types of alloys and the heat treating methods to include in a test program. Develop a plan of testing, including a set of rules that will persuade the workers to use these new tools. Be sure to justify why you selected the alloys and treatment methods you did, and be sure the rules you develop would be acceptable to Mr. Taylor.

3) Compare and contrast plain carbon steel, alloy steel, stainless steel, and tool steel.

4) Discuss solution hardening. Sketches required.

Guidelines:

1. Maximum length: 20 pages.
2. Double space, 12 pt type, universal or Geneva font.
3. No binders or folders.
4. Use cover sheet.

MARK CLARK
Mark Clark is an Associate Professor of History at the Oregon Institute of Technology. He was a Fulbright Research Fellow at the University of Aarhus, Denmark in 1997, and continues to work closely with a number of Danish scholars on the history of magnetic recording. Dr. Clark received a B.S. degree in Mechanical Engineering from Rice University in 1984 and a Ph.D. in the History of Technology from the University of Delaware in 1992.

DONALD MCMURCHIE
Donald McMurchie is an Associate Professor and Chair of Manufacturing Engineering Technology at the Oregon Institute of Technology. He is currently involved in OIT's distance education efforts and the integration of humanities instruction into the engineering curriculum. Dr. McMurchie received a B.S. degree in Manufacturing Technology from Oregon Institute of Technology in 1991 and a Ph.D. in Materials Science and Engineering from the Oregon Graduate Institute of Science and Technology in 1996.