Engineering Technology Curriculum Integration in an Associate Degree Program

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Introduction

The 16 technical colleges of the Technical College System of South Carolina in partnership with industry, public education, and the National Science Foundation (NSF-ATE DUE 9602440) have begun a five-year odyssey to reform the educational programs for engineering technology. This reform is needed because of two forces driving curriculum change. First, industry leaders emphasize that technicians need more than technical skills in the changing industrial environment. Second, knowledge gained from educational research on learning theory, new classroom methodologies, and improved instructional technology has made these changes possible. To reform the curriculum, interdisciplinary (mathematics, science, technology, and communication) faculty teams from across the state were formed and participated in faculty development activities involving learning theory, classroom methodologies, and instructional technology.

Background

The business and industrial environment in the United States is in a state of change caused by the challenge to remain competitive in the world market. To successfully meet this challenge, industry must have a workforce that is well prepared, not only in technical skills, but also in teaming, communications, and problem solving. There is a shift occurring in the traditional industrial worker to become a technologist who works both with hands and with theoretical knowledge. Thus we can expect to see an expanding role of the "technician," especially the engineering technician within the manufacturing environment. Therefore, the role of the technician is not simply a "junior professional" but rather a collaborative partner who possesses a distinct body of heuristic knowledge and who has a unique set of activities to perform. The role of the engineering technology program is to identify the unique characteristics of the technician and to create an educational environment to fulfill the needs of industry in this changing situation. It is important that the educational programs model the workplace environment and not just teach about it.

Educational research provides guidelines for curriculum reform. Gardner[1], in his concepts of multiple intelligences, indicates that students have seven different intelligences with each having various degrees of development. Felder[2] has stated that the learning styles of students vary and that each style requires a different instructional strategy for effective learning to occur. Redich[3] states that in the physics class "we will have to shift our emphasis from the physical content we enjoy and love so well to the students themselves and their learning. We must ask not only what do we want them to learn, but also what do they know when they come in and how do they interact with and respond to the learning environment and content we provide." Several engineering programs have initiated integrated freshmen curricula[4,5,6] that integrate entry level content from several disciplines. They show that these programs can be effective in developing a better understanding of content and improving problem solving abilities. Experiments in problem-based learning show that this approach allows for the incorporation of these new instructional methods.

The current educational model established in the 19th century was to facilitate an agricultural society and has had only slight changes to reflect the influence of the assembly line manufacturing structure. This current model consists of isolated courses divided into isolated disciplines and taught in semesters or quarters. This isolation has built barriers not only between courses but also in many cases between the faculty in the different departments that teach these courses. In order to improve the education of technicians, these barriers must be removed along with the isolation of the disciplines. Industry does not operate in an isolated compartmentalized manner, and employees expect the technician to be able to function in an environment that requires them to integrate the skills from many disciplines (mathematics, science, communications, and technology) to solve problems. Figure 1 shows the contrast between the isolated discipline educational model and integrated use of knowledge on the job.

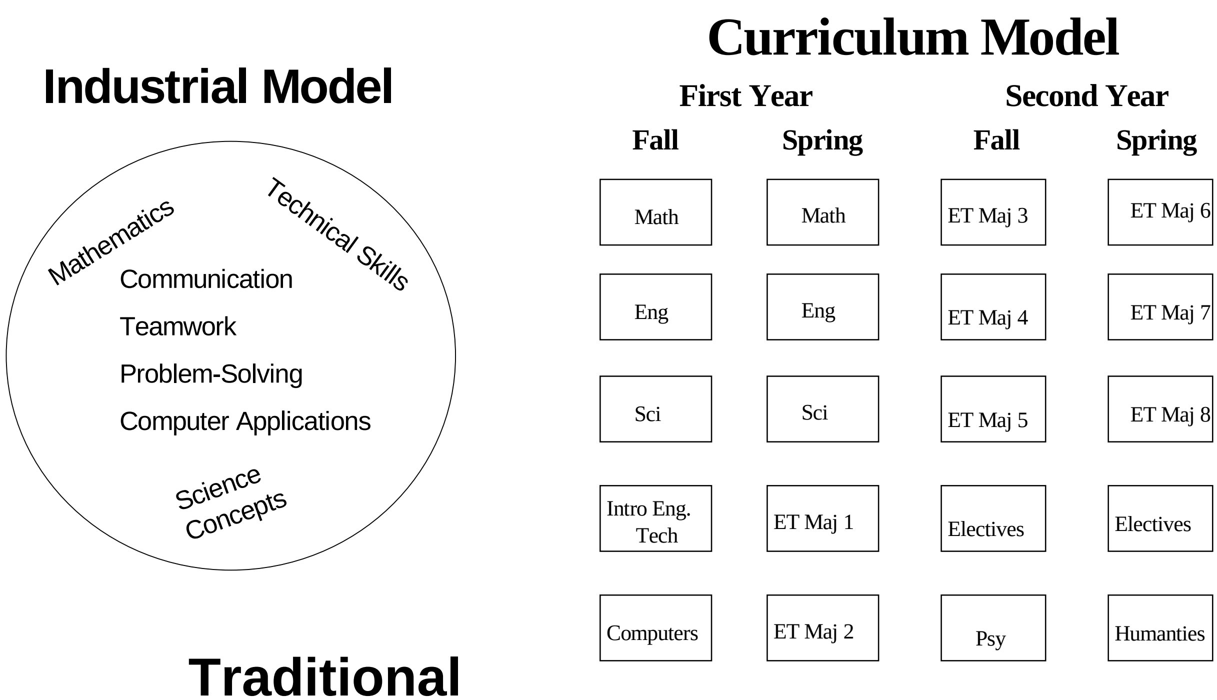

Figure 1

Design Objectives

In the initial phase of the project, design teams comprised of faculty from the technical colleges developed criteria for the curriculum. The following factors have been considered in developing the structure of the curriculum.

- Many students enter college under-prepared.
- Students learn best in a contextual environment.
- Students do not transfer mathematical and science skill well into other programs.
- Integration of disciplines (mathematics, science, communications, and technology) can improve understanding of discipline relationships.
- The classroom environment must model the workplace environment and include:
  - team building;
  - communications; and
  - problem solving.
- Problem based learning must employ industrial examples.
- Introductory modules must support broad-based advanced ET majors.
- Requirements of accreditation agencies must be met.
- Course structure must support both day and evening programs.
- Most students are not full-time.
- Graduation in two years requires that introductory courses and some major courses be concurrent.
- Course structure must support transfer into and out of the program.

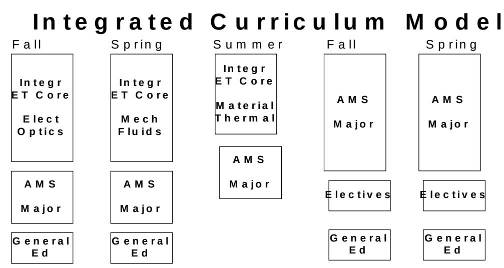

Figure 2
Curriculum design

These factors lead to a structure that has several sizes of blocks of courses and may result in an integrated block containing several courses but taught as a required concurrent set. Such a structure is shown in figure 2.
To meet these criteria, the curriculum development will have three major components (a Pre-Engineering Technology (Pre-ET), an Engineering Technology Core (ET-Core), and Advanced Manufacturing Specialties (AMS)) to create a seamless curriculum from high school through an associate degree technical program and beyond if desired. (See Figure 3)

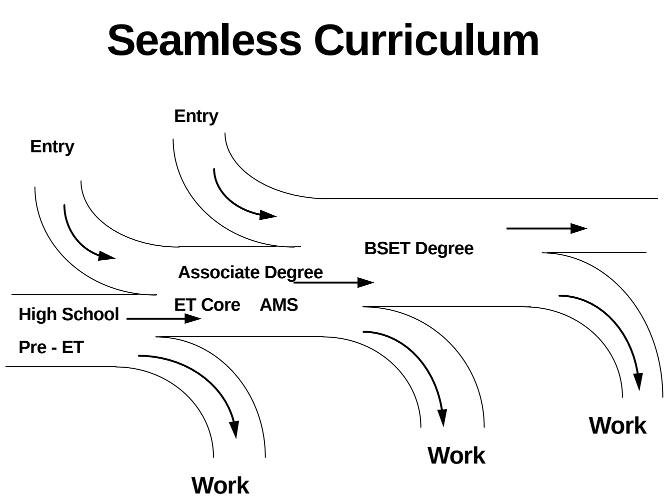

Figure 3

The Pre-ET first ensures that entering high school graduates are ready for an educational environment that uses active learning methods involving teaming and an integrated problem-based learning model. This program also gives under-prepared students a method to upgrade their skills to meet the demand of the new ET curriculum.

The ET Core integrates the disciplines of mathematics, science, communications, and basic technology into a sequence of problem-based learning, integrated modules employing active learning strategies to prepare the students to enter into any number of engineering technology majors (AMS). These modules will utilize contextual examples from industry and model the workplace environment.

The AMS will revise major curricula to build on the skills learned in the core and incorporate new and emerging technology programs.

The ET Core is designed around six major physical systems, electrical, mechanical, thermal, fluid, optical, and material (figure 4) that form the basis for the AMS. Development teams consisting of faculty from mathematics, science, technology, and communications were formed for development of curriculum modules. The work of each of these development teams was directed and coordinated by a Curriculum Oversight Team comprised of faculty representing each of the disciplines. Each module integrates the disciplines of mathematics, science, technology, and communications to create an active learning, problem-based learning environment that mirrors the workplace environment. To design an integrated module it was assumed that the students enter from the pre-ET with basic mathematical and communications skills and exit with skills necessary to enter the "first" of the Advanced Manufacturing Specialty courses. The development team first identified the ET concepts and laboratory skills needed in the area of study. Then the team determined the supporting science concept and math skills. Concurrent with the development of the technical competencies, team members also developed a framework for communications, team building, computer competencies, and workplace readiness skills. These overarching themes were then integrated into the ET-Core.

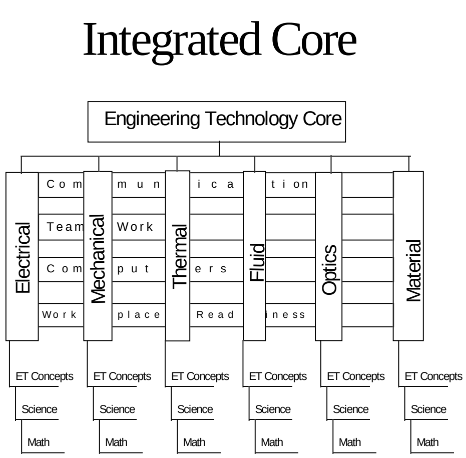

Figure 4

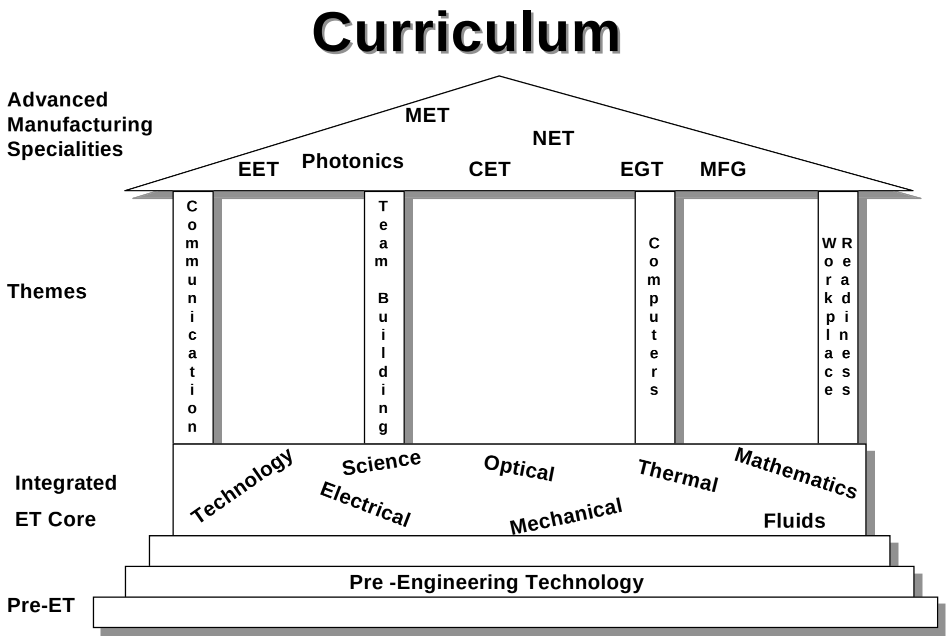

Figure 5

The overall design of the curriculum can be illustrated by figure 5 which shows the Pre -ET as the steps to the curriculum, the ET-Core as the base for the curricula, and the themes as the support for the Advanced Manufacturing Specialties. Development on the AMS component of the curriculum must wait for definition of the final skills from the ET-Core and will be completed in the next year.

Summary

The technician of the future will need more than technical skills. Technicians will have to have teaming, communicating, and problem-solving skills. Also, in order to model the workplace in the classroom, new methods of instruction are needed.

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2. Felder, Richard, " Matter of Style, " **ASEE Prism** December 1996.
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