COUNCIL ON TECHNOLOGY TEACHER EDUCATION
An affiliate council of the International Technology Education Association

CTTE Monograph 11

Elements and Structure for a Model Undergraduate Technology Teacher Education Program

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Undergraduate Studies Committee

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Preface

Specific definitions were assigned to the following words to make the reading and writing of the monograph easier. The words are:

technology (not capitalized): . . . knowledge and study of human endeavors in creating and using tools, techniques, resources, and systems to manage the man-made and natural environment for the purpose of extending human potential and the relationship of these to individuals, society, and the civilization process. (Snyder & Hales, 1981, p. 2)

Technology: A comprehensive, action based educational program concerned with technical means, their evolution, utilization, and significance; with industry, its organization, personnel systems, techniques, resources and products; and their sociocultural impact (AIAA, 1985, p. 25)

Technology education or Technology teacher education: An undergraduate program designed to prepare teachers to teach Technology in elementary and secondary schools.

In 1986, the American Council on Industrial Arts Teacher Education (ACIATE), now named Council on Technology Teacher Education (CTTE), embarked on the ambitious task of developing a Professional Improvement Plan. This endeavor grew out of the mission statement which stated that the "Council is to provide leadership in supporting the development of quality teacher education programs in Technology Education/Industrial Arts." Specific goals established to facilitate the mission were:

1. Provide input to and support for the goals of the International Technology Education Association.
2. Identify and operationalize the components and criteria for quality Technology teacher education programs.
3. Develop and promote an awareness of and support for implementing quality Technology teacher education programs.
4. Encourage and assist members in their professional development.
5. Stimulate research and scholarly activity that will advance quality Technology teacher education.

The Undergraduate Studies Committee addressed the second of these goals. The result is this monograph describing the design and components of a quality undergraduate technology teacher education program. This document was necessitated by two major movements, one in society and the other in the discipline.

The movement in society refers to the simple but evasive fact that technology continues to grow at an exponential rate. The distance between the technology specialist and the citizen on the street has widened and continues to spread. Developed countries such as the United States are finding that decisions with important economic, political, and social impacts are being made increasingly by technical experts because most people do not know enough to make informed decisions. Rustum Roy (Krieger, 1987), director of Pennsylvania State University's Science, Technology, and Society program, stated that "Effective citizenship demands a new kind of literacy in technology and science that cannot be met by adding a course in algebra" (p. 26). John H. Gibbons (Krieger, 1987), director of the Office of Technology Assessment in Washington, suggests three imperatives that drive the need for technological literacy.

> One . . . is the economic necessity of technological literacy for the individual - for example, in job skills needed - and for the competitiveness of the nation. The second is that the responsibilities for citizenship now demand that citizens raise their level of literacy about the issues on which their representatives are having to make decisions.
>
> Third . . . is that the fullness of human development and the very enjoyment of life itself more and more depend on things that include not only Superbowl but supercolliders, superconductivity, and lots of super things. (p. 27)

Hence, changes in our society and culture as a result of expanding technology have necessitated a review of our discipline, that has the tremendous responsibility of addressing technological issues most directly.

Reassessment of our discipline is essential in an age of rapid technological expansion. Such a reassessment occurred at the Jackson's Mill conference where the philosophy and content of technology/industrial arts education were examined and articulated for the '80's and '90's. To be sure, the contents of our programs must be scrutinized periodically in order to provide the most relevant education for our youth.

As useful as the Jackson's Mill document (Snyder & Hales, 1981) is for laying out what needs to be taught, the task of translating the end goal into teacher education preparation remains the task of the Council on Technology Teacher Education and, more specifically, the Undergraduate Studies Committee.

The primary purpose of this monograph is to offer a model for a Technology teacher education programs that can be used in planning new programs as well as in revising and updating existing programs. The Technology Teacher Education Model illustrated in Figure 1 consists of three elements that are held together with the Rationale. In the Rationale, Technology (a curricular program) is defined, the need for Technology programs is explained, and the steps for implementing a model Technology program is described.

The elements in the Technology Teacher Education Program are General Education, Technical Competency, and Professional Education. A focused statement of rationale, content outline, course structure, and description of courses are included in the section describing each element.

Unless Technology teacher education programs make intelligent choices and adaptations, the products of these programs--Technology teachers--will be obsolete before they graduate. Furthermore, the programs in which they teach may well be relegated to the periphery of education instead of the core where technology education needs to be.

The role of undergraduate Technology teacher education must not be underestimated. The quality of Technology programs in our schools is directly related to the quality of the teacher education programs that produce teachers. Since teacher education programs have only a limited ability to change practicing teachers, the necessity for educating teachers who are leaders in the field is crucial. Undergraduate Technology teacher education is essential to the success of Technology programs of instruction.

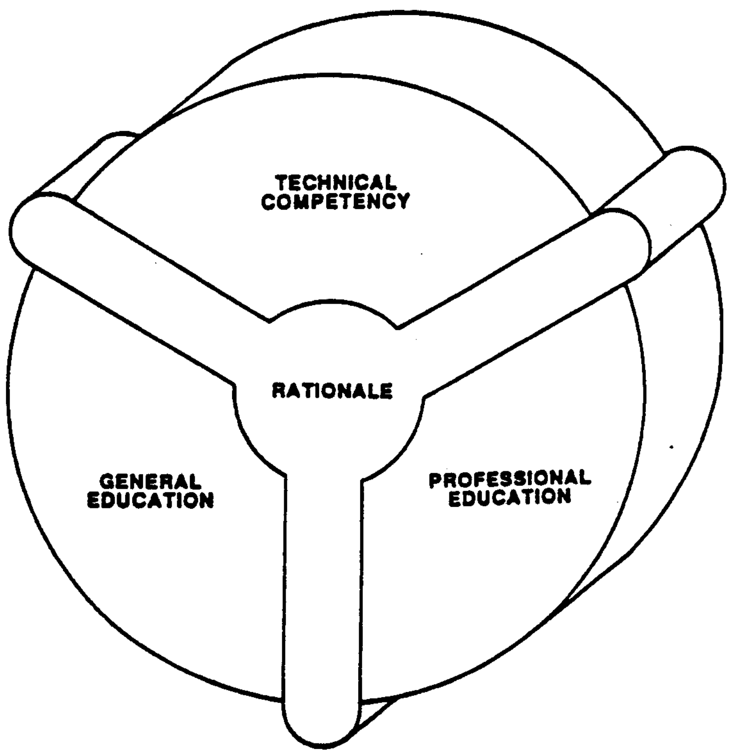

Figure 1. A Rationale and General Education, Technical Competency, and Professional Education Elements make up this model of a Technology Teacher Education Program.

Chapter 1

A Rationale

Writing a rationale helps program developers in three important ways. By going through the process of writing a rationale, it builds their understanding and clarifies their thinking about teaching. Once written, the rationale serves as a guide during the search for alternative solutions and as a basis for deciding among them. Finally, faculty are prepared to respond to students when they ask, "Why did you select these objectives and organize them this way?"

In Figure 1, the Rationale appears to be the glue that holds the three elements of the Technology Teacher Education Program together. You can see in Figure 2 that answers to three crucial questions are used to direct decision making in the curriculum development process. The questions are:

1. What is Technology?
2. Why teach Technology?
3. How are Technology programs implemented?

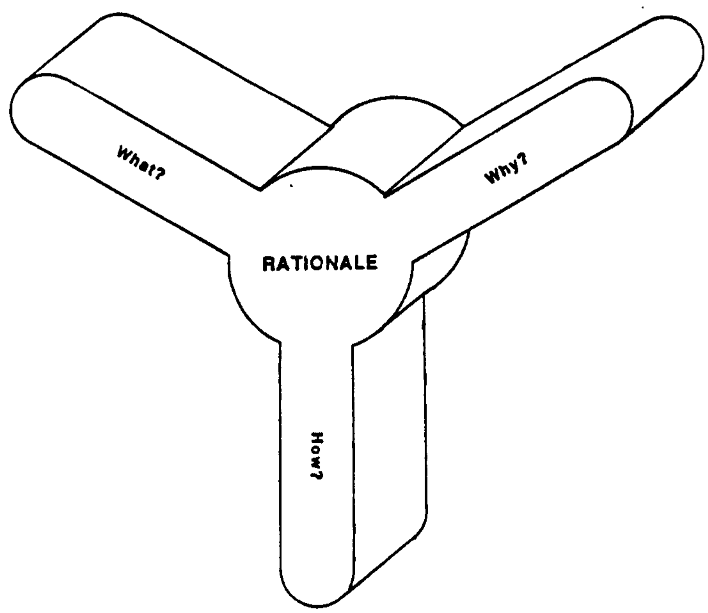

Figure 2. The Rationale provides the basis for making curricular decisions relative to what should be taught, why it should be taught, and how it should be implemented.

What is Technology?

Over the last 20 or so years, the level of agreement and understanding of the subject matter for Technology has raised considerably. Technology has become the primary focus. Greater emphasis in the content is placed on principles, concepts, and processes than on knowledge itself. Knowledge is viewed more as a changing commodity which is to be researched or discovered at the time when it is needed to solve problems or make decisions, and less as the primary goal of the learning experience.

As a forerunner of Technology, in 1981, the *Jackson's Mill Industrial Arts Curriculum Theory* (Snyder & Hales) was completed and presented a significant contribution to the profession by addressing major curriculum concepts and content. The contributors to this document are recognized as leaders in our profession. At this time, no other single document appears to have more support in the profession than does the *Jackson's Mill Industrial Arts Curriculum Theory.* Therefore, concepts found in the Jackson Mill document were used extensively in the writing of this monograph.

The concept of human adaptive systems is one essential concept borrowed from the Jackson's Mill document. The document states that "The evolution of human beings and their social and technical orders can be understood by analyzing three human adaptive systems; the technological, sociological, and ideological" (p. 6). A human adaptive system is defined as:

> That they are *human* separates them from those that exist in lesser forms of life. That they are *adaptive* implies that people constantly seek accommodation with their environment. That they are *systems* suggests there is some regularity to human adaptive behavior and that the elements of the system relate in orderly, predictable ways. (p. 10)

Technology is concerned with the human adaptive system that exists as part of the natural and man-made environment and is referred to as a technological system. As it is defined by the *Jackson's Mill Industrial Arts Curriculum Theory* authors, "Technological systems pertain to the technical means of manipulating the physical world to meet basic needs of survival - food, clothing, shelter - as well as providing other goods, services, and means for extending human potential." (Snyder & Hales, 1981, p. 6)

Traditionally, the universal technical systems are studied from the view of the industrial component of the economic institution. From this perspective, the technological subsystems of communication, construction, manufacturing, and transportation evolved. In this document, biotechnology was added to the group of universal technical systems because biotechnology fits the definition of technological systems, is uniquely different from the other four subsystems, and is an integral part in two of the newest textbooks (Hacker & Barden, 1987; 1988) being published for Technology programs.

While no single definition of Technology is likely to be accepted by everyone in the profession, the definition by AIAA (1985) stated earlier appears to contain the essential elements that appear in contemporary literature by scholars in the field. Technology utilizes a comprehensive methodology that helps students learn about technological concepts, systems, and resources. This emphasis must be recognized by teacher educators as essential. If this emphasis is practiced by those preparing Technology teachers, then new teachers can be expected to possess and communicate to their students these skills, concepts, and methods of studying technology.

More specifically, the skills of problem solving must be practiced throughout the Technology teacher education programs (Costa, 1985, p. 4; National Science Board, 1983, p. v). According to Costa (1985), "most teachers do not regularly employ methods that encourage and develop thinking in their students" (p. 5). The challenge to Technology teacher educators is to emphasize the importance of problem solving and the appropriate methods for solving technological problems in each course regardless of the title. Given sufficient instruction and practice in problem solving, students will be able to realize the importance and utility of this skill. With the rapidly accelerating expansion of knowledge and the accompanying rate of technological change, skill in problem solving is a vital element in every person's education.

Why Teach Technology?

The growth and use of technology has altered the nature of society in many positive ways. Among them are extended life, increased comforts, and people liberated from drudgery. However, the rate and magnitude of technological change is, also, impacting society in ways that endanger, confuse, alienate, and reduce the significance of an ever-increasing segment of people. The ability to apply technology has given people freedom to do as they please which can result in an arrogance that tends to make them self-centered and insensitive to others and to the environment. Finally, rapid change has contributed to making the future less certain and less clear.

Appropriate Technology curriculum provides people with tools in the form of knowledge of principles, concepts, and techniques and with a sense of responsibility. The tools and sense of responsibility can be used to develop, apply, and control technology in ways that enhance our sense of personal worth, preserve our natural systems, and direct the use of technology towards achieving social purpose and conserving our natural resources.

The time has come to seriously consider making critical thinking a major goal for teaching and learning in our schools in general and in Technology in particular. The focus on the development of thinking skills is education's best response to the obsolescence problem posed by the knowledge explosion. The technological changes that we are experiencing in the last decades of this century are creating needs that have not existed previously. The fact that "scientific and technical information now increases 13% per year, which means it doubles every 5.5 years" (Naisbitt, 1982, p. 24) has had a great influence on the rate of technological change. Lauda and McCrory (1986) presented a rationale for the study of Technology in the 1986 ACIATE yearbook that is timely and appropriate. This rationale is based on the changing needs of a society that has moved from an industrial base to an information base. The study of technology, as a discipline, is advanced as an effective process to transmit knowledge from one generation to the next which enables humans to adapt to the environment in which they must live.

An article in *Business Week* (Oct. 19, 1987) addresses the move by school systems to wage the battle against technological illiteracy as well as teaching the basics of reading, writing, and arithmetic. This move was prompted, in part, by the report by the National Commission on Excellence in Education (1983) that expressed concern that students would not be able to function in an "increasingly technological workplace." (p. 114)

Technological literacy is not something that is left behind when an individual leaves the workplace. It is an essential element in everyone's life in our society, no matter what their occupation might be. The underlying key to developing a country of technologically literate citizens lies in the hands of the Technology educators (Swyt, 1987). It is their responsibility to provide the education that will permit people to adapt to the rapidly changing society and to contribute to the realization of new technologies. This must be accomplished by providing direction and preparation through strong, relevant, and dynamic technology teacher education programs.

The development of an undergraduate Technology teacher education program that meets present needs but is able to change as new needs emerge is essential. Students in these programs must learn that the ability to adapt to change in a responsible way is possibly the greatest skill that can be acquired. They must be convinced that change is the only sure thing in their future; and their success and that of their students depends on their ability to participate in these changes in a responsible manner.

How are Technology programs implemented?

Considerable discussion has taken place in recent years regarding Technology and its role in our educational system. On one front, the argument was pursued over whether Industrial Arts was to be replaced by Technology. Another source of unending debate involves the question of exactly what should a Technology curriculum include. A review of some of the most recent literature will reveal that emphasis is being placed on how and when Technology programs will be implemented and not if they should be implemented. In referring to the tremendous challenge to the profession in making this transition to Technology, Maley (1987) states that, "The transition from Industrial Arts to Technology Education was a bold and relevant move on the part of the profession." (p. 3)

The more relevant questions that emerge, concentrate on how Technology should be implemented in our school systems. Lauda and McCrory (1986) cite five steps that are necessary to accomplish the implementation of a Technology program. These steps are, "(a) develop a curriculum design, (b) develop a curriculum plan based on the design, (c) develop instructional materials to support the curriculum, (d) provide inservice training for teachers and administrators, and (e) field-test, evaluate and revise the program." (p. 31)

This monograph presents a model for an undergraduate Technology Teacher Education curriculum that will prepare future teachers to effectively design, implement, evaluate, revise, and promote Technology programs in grades K-12. The proposed program represents a curriculum design that includes three elements - Professional Education, General Education, and Technical Competency. The curriculum plan encompasses both new content and an instructional strategy for teaching it.

Teacher educators need to spend considerable course planning time on choosing or developing student activities that are cast in settings in which principles, concepts, and processes are used to solve relevant problems in a real or simulated context. Collaborative group strategies are recommended to enhance learning and develop participatory skills needed by future citizens.

The Program must be closely articulated. All elements of our technological world contribute and cooperate as never before. More interaction between faculty members from various departments is encouraged. As was stated repeatedly at Technology Education Symposium IX (Robb and Kozak, 1987), Technology and technologically-related areas will need to rely on each other to keep abreast of the developments and the needs of our society.

Students should be viewed as valued colleagues, who are capable of, and interested in, thinking creatively in solving relevant and significant technological problems that contribute to the improvement and stability of the world. Further, students possess a variety of characteristics and when they are channelled into meaningful projects in which the students' strengths are utilized, students will become more self-directed while the instructor can, then, assume the role of facilitator.

The educational needs of the future must be considered when planning a curriculum for today and tomorrow. Technology instruction is not new, many of the concepts have been in existence for over a decade. To continue to dwell on programs and curricula that "have served us well for many years" will jeopardize the quality and nature of the education of students for generations to come. The tendency for programs to change slowly in education must be avoided and a proactive attitude established to promote rapid acceptance of Technology as an essential part of every person's education.

The urgency in establishing a Technology program in all schools is not an exaggeration. The Technology Teacher Education Program, as it appears, was based on current educational theory. Establishing undergraduate programs such as the one described in this monograph must have a high priority. The students we are educating now will be teaching for several decades. The future of the coming generations and their ability to live and prosper in a technological world depends on how quickly Technology programs are implemented.

Chapter 2

General Education Element

Need for General Education

The educational needs of all people in future generations will be different that those demanded by today's society. Technology teachers of tomorrow will need to receive an educational preparation that will provide them with the ability to meet, apply, and understand the technology of the future.

A conceptual view of the General Education Element, shown in Figure 3, is described in terms of goals, content areas, and concepts. The General Education Element is designed to reach several goals. Among them are to develop skills and competencies, to gain knowledge about the world from which the student has come and in which he/she will live, and to develop perspectives appropriate for a citizen in an inter-dependent world.

Students need to develop communication skills in order to express ideas with clarity, conciseness, and enthusiasm in both written and spoken forms. The development of critical thinking and decision making skills is equally essential. Students in our society also need to strengthen computer usage skills and their ability to use mathematics to solve a variety of problems. These goals are not unique to the preparation of Technology teachers but are appropriate for all college students regardless of specialization.

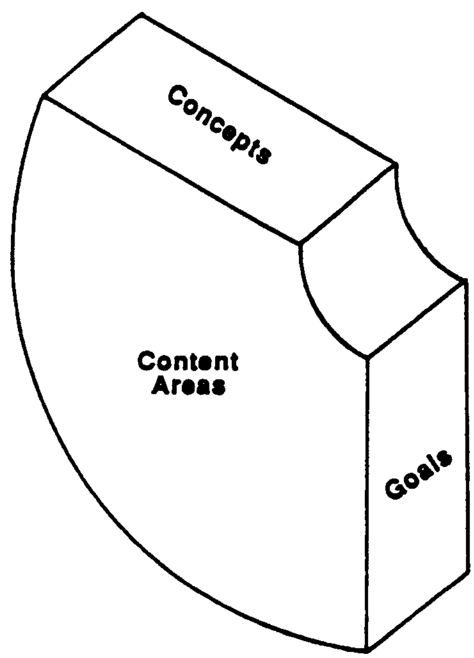

Figure 3. The General Education Element is described as having three dimensions - Goals, Content Areas, and Concepts.

Prospective Technology teachers need to achieve the goals in the context of content areas. In order to understand their heritage, students must study not only history, but also the fine arts and humanities. The invaluable information and concepts learned in the social sciences will help prospective Technology understand why people behave as they do as individuals, as well as in society. They will be able to observe and explain changes in the importance of different institutions over time.

The natural sciences consist of physical, biological, geological, and chemical sciences. The sciences describe the natural laws that restrict but give order to our lives on the one hand, but may be used for technological development on the other.

Each subject has concepts that are unique. What has been described thus far could be stated for any general education curriculum project. However, the Technology teacher needs more mathematics and science. Some of the unique features of the

General Education element include sections on technological literacy, global studies, futuring, and wellness. The concept of wellness refers to more than physical fitness. It also addresses coping and stress management skills, which is in response to the stressful and complex world in which we live.

The addition of technological literacy into the general education curriculum (for all students) acknowledges the role of technology in our society and, perhaps more importantly, identifies the need for citizens to understand the ways by which technological decisions are made. The effects of technology cut across all disciplines and all aspects of our lives; hence, technological literacy should be taught as an interdisciplinary course.

Global studies are essential as one recognizes the continuing breakdown of the lines that separate nations. Nations from opposite sites of the globe are becoming increasingly dependent on each other. Understanding and respecting other cultures is a necessary part of international and national citizenship. Students need the opportunity to contemplate the nature of these international relationships and the potential of technology and applied sciences for improving and destroying life. Futuring supplies the tools for dealing with these phenomena with the purpose of encouraging students to become actors in forming the future as opposed to being helpless or reactionary observers.

Preparing students with competencies they will need as teachers, individuals, and citizens for a challenging future society is not an easy task. It demands a joint effort by faculty in all disciplines.

General Education Element

The General Education Element is designed to provide Technology Teacher Education majors with the concepts, understandings, skills, and values necessary for educated men and women to live purposefully in a modern technological society.

A. Language skills
  1. Written communications
    a. Sentence structure
    b. Effective dictation
    c. Organizing ideas
    d. Paragraph composition
    e. Spelling
    f. Short research paper writing
  2. Oral communications
    a. Designing presentations
    b. Delivery methods
    c. Group techniques
    d. Voice production and control
    e. Persuasion methods

B. Humanities
  1. Literature
    a. Early world through the 18th century
    b. 19th and 20th century literature
    c. Current events
  2. Fine arts
    a. Recognize basic elements and components of works
    b. Principles and relationships of the elements of design and composition
    c. Vocabulary and the use of symbols
    d. Relationships between the various fine arts

C. Mathematical Science
  1. Algebra
    a. Graphs
    b. Exponents and radicals
    c. Linear and quadratic equations
    d. Probability
  2. Trigonometry
    a. Trigonometric functions
    b. Vectors
    c. Exponents and logarithms

D. Technological Literacy
  1. Technological Systems
    a. Types of systems
    b. Models of systems
    c. Confluences of systems
    d. System Theory
  2. Some typical areas of competence
    a. History of technology
    b. Processes of technology
    c. Research and development
    d. Levels of technology
    e. Technological assessment
    f. Transfer of technology
    g. Appropriateness of technological means
    h. Tools of technological decision-making
    i. Design theory
    j. Social impact of technology
  3. Technology and the economic context
    a. Trends
    b. Productivity
    c. Competition
    d. Others
  4. Computer Literacy (using micro-computers)
    a. Application software (word processing, spreadsheet, data base, instruction)
    b. Communication

- c. Control
- d. Networking
- e. Introduction to programming

E. Natural Sciences
1. Applied Physics
   - a. Vectors
   - b. Mechanics
   - c. Hydrostatics
   - d. Heat
   - e. Thermodynamics
   - f. Electricity and magnetism
   - g. Light/Lasers
   - h. Color theory
   - i. Sound
   - j. Energy and its transformation
2. Applied geological science
   - a. Introduction to major areas (astronomy, geology, meteorology, oceanography)
   - b. Human geography
   - c. Economic geography
   - d. Ecology
3. Applied biological science
   - a. Human sexuality
   - b. Nutrition
   - c. Health and disease
   - d. Evolution
   - e. Physiological processes
4. Applied Chemistry
   - a. Atomic structure
   - b. Bonding
   - c. Chemical reactions
   - d. Acids and bases
   - e. Solutions
   - f. Electrochemistry

F. Social Sciences
1. Psychology
   - a. Principles of behavior
   - b. Development of the individual
   - c. Motivation
   - d. Emotions
   - e. Cognitive processes
   - f. Testing
   - g. Personality
   - h. Behavior disorders
2. Sociology - examples
   - a. Interactions between human beings
   - b. Natural and social heritage
   - c. Meanings and functions of culture
   - d. Characteristics of the social institutions
   - e. Social/societal patterns
   - f. Technology as a social change agent
3. History
   - a. Early world
   - b. United States of America
4. Economics
   - a. Economic analysis techniques
   - b. Mechanics of the market system
   - c. National income
   - d. Inflation and unemployment
   - e. Entrepreneurship
5. American government
   - a. Basic principles of the American system
   - b. Organization and function of the system
   - c. Political parties
   - d. Civil rights
   - e. Regulatory functions of the government
   - f. Responsible citizenship
6. Global studies
   - a. The world as a system
   - b. Current state of the world
   - c. Independence-interdependence
   - d. National security-global service
   - e. The global economy
7. Futuring
   - a. Extrapolation and projection of current trends
   - b. Imaging the future
   - c. Skill and strategy building for designing the future

G. Wellness
1. Physical fitness
   - a. Exercise
   - b. Weight management
   - c. Nutrition
   - d. Chemical dependency
2. Mental fitness - examples
   - a. Stress management
   - b. Coping skills

A Structure for the General Education Element

The general education requirements are often established for the entire college or university rather than meeting the needs of specific curricula. In addition, influences are made by accreditation agencies and state department of education teacher certification standards. The general education requirement usually includes a block of specific courses in various disciplines, elective courses within disciplines and a free elective component.

RECOMMENDED 48- HOUR GENERAL EDUCATION STRUCTURE

Language Skills - 9 credits	
Written Communications	
English Composition I	3 credits
English Composition II	3 credits
Oral Communications	3 credits
Technological Literacy - 6 credits	
Technology Literacy	3 credits
Computer Literacy	3 credits
Humanities - 3 credits	
Literature	3 credits
Fine arts	3 credits
Natural Sciences - 9 credits	
Applied Physics with Laboratory	3 credits
Applied Chemistry with Laboratory	3 credits
Applied Biological Science with Laboratory	3 credits
Applied Geological Science with Laboratory	3 credits
Mathematics Courses - 6 credits	
Algebra	3 credits
Trigonometry	3 credits
Social Science - 12 credits	
American Government	3 credits
Economics	3 credits
Global Studies/Futuring	3 credits
World History	3 credits
Psychology	3 credits
Sociology	3 credits
Wellness - 3 credits	
Suggested Additional Electives (Credits will depend on institutional requirements)	
Applied Physics II with Laboratory	3 credits
Applied Chemistry II with Laboratory	3 credits
Computer Programming	3 credits
Pre-Calculus	3 credits
Foreign Languages	6 credits
Technological Literacy	3 credits

The General Education Element will vary in the total number of credits or semester hours according to college or university practices. The average credit hours required for graduation is 125 to 135 credit hours. The typical required general education component appears to have approximately 48 credit hours and is recommended for the General Education Element for Technology teachers. A suggested structure for the General Education Element is described below.

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Courses in the General Education element

The courses in the General Education Element are typically taught by liberal arts faculty. To insure that content and structure of general education courses are meaningful, curriculum planners are encouraged to work cooperatively with instructors in the various discipline areas in the development of courses that service Technology teacher education programs.

A review of the General Education Element outline would suggest both a reaffirmation of the traditional liberal arts and sciences as well as the need for different approaches to the teaching and organization of courses. Special emphasis needs to be placed on the development and application of concepts in the following courses: Applied Physics, Applied Geological Science, Applied Chemistry, and Applied Biological Science. Mathematics courses should cover the concepts of algebra and trigonometric functions with practical applications to the other sciences and to technology. At the same time, the flexibility, adaptability, and breadth developed by the traditional liberal arts and sciences is affirmed.

At some universities, new courses need to be developed in computer literacy, technological literacy, global studies and futuring, and wellness. These courses could and perhaps should be team-taught with faculty from other disciplines or be taught in the major department. Due to credit limitations, a new course that includes both global studies and futuring may be developed. If the situation permits it, two new courses may be developed on each of the topics. Technology makes a global impact through the use of biotechnical, communication, construction, manufacturing, and transportation systems. The pressure and strains of our complex technological society have an effect on the wellness of the human race; thus, courses on physical and mental well-being are an essential part of the general education element.

Within this General Education Element, the traditional discipline courses will need to incorporate the many impacts of technology into the content. New teaching strategies will need to be used to achieve the new objectives. The teachers of tomorrow will find the opportunity to learn from non-traditional and new interdisciplinary courses which must become a part of their Technology teacher education program.

Chapter 3

Technical Competency Element

Structuring the Subject Matter for Technology Education

The purpose for structuring technological subject matter is to provide Technology teacher educators with a means to sort out the components of the subject matter and classify them in a meaningful way. The problem of developing a structure for technological subject matter is a difficult one. First of all, technological subject matter is very diverse and complex. Fortunately, over many years, professionals in our field (Bame & Cummings, 1980; DeVore, 1980; Hacker & Barden, 1988; Towers, 1966; Seymour, Ritz & Cloghessy, 1987; Snyder & Hales, 1981; Wright, 1976, 1987) have put considerable effort into identifying and structuring the subject matter for Technology courses. Secondly, technical knowledge is evolving and being generated at an increasing rate. A lasting structure must be based on undergirding principles and elements rather than focusing on the point of practice. A third complication results when one tries to reconcile the diversity of contemporary interpretation of the new and changing subject matter into classroom practice. Some curriculum revisions are little more than changing the names of courses and the categories for grouping existing content. In other cases curriculum revisions resulted in writing new courses, purchasing new and different equipment, remodeling the facilities, and changing the methodology used in the laboratories and classrooms. The writers chose the latter approach. Finally, should the structure represent the best examples of "what is" or should it be visionary and reflect "what ought to be"? The goal of the Undergraduate Studies Committee was to be more visionary than reflective.

In coping with the problem of synthesizing the subject matter, a systems theory was used as the subject matter organizer for the Technical Competency Element. A system involves combinations of elements or parts. When the parts of a system work together, they accomplish a desired goal. The universal concept of system (Snyder & Hales, 1981, p. 10) is used to assist in understanding the construct of "system" and is pictured in Figure 4.

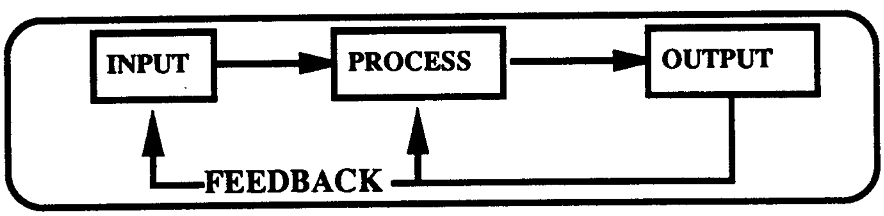

Figure 4. Universal Systems Model.

In *Jackson's Mill Industrial Arts Curriculum Theory*, Snyder and Hales (1981) described a universal system in the following way:

> The "inputs" to the system provide all needed resources to accomplish the goals of the system. The "processes" are the means (the appropriate means) of bringing about system goals using the inputs (resources). The "outputs" of the system include the ends or goals (products, services, or desired results) as they become parts of the newly accommodated environment within the sociocultural context.
>
> The "process" portion of the model provides us with the boundaries of our unique discipline. Within the process boundaries are to be found the concepts, principles, generalizations, and unifying themes of technology (the knowledge of appropriate technical means). (p. 11)

Feedback comes in many forms to regulate and direct the system. Snyder and Hales (1981) describe it this way, "A system requires assessment, adjustment, and constant redirection. There must be adequate feedback mechanisms to provide the preferred directions for the system" (p. 13-14).

The model shown in Figure 5 shows the Technical Competency Element with three dimensions - Technological Subsystems, System Perspectives, and Impacts. The content for Technology programs is drawn from five technological subsystems. Communication, construction, manufacturing, and transportation were the four "subsystems of human technical endeavors which exist to extend human potential" described by Snyder and Hales (1981, p. 23). The fifth subsystem is biotechnology. Biotechnology content has become better defined since Jackson's Mill meetings were added for two reasons. Biotechnology satisfies the definition of a technological subsystem. Secondly, two of the newest textbooks (Hacker & Barden, 1987, 1988) published for Technology courses include significant sections and activities in biotechnology.

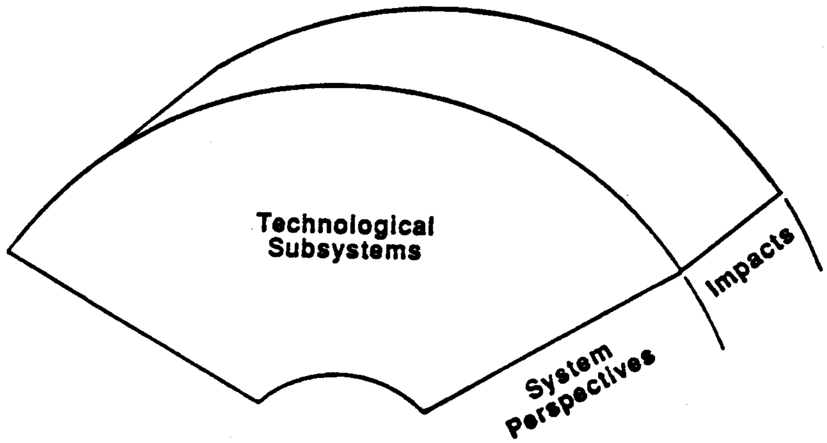

Figure 5. The three dimensions of the structure for the Technical Competency Element are Technological Subsystems, System Perspectives, and Impacts.

Each subsystem has an input, process (productive processes and managerial processes), and output component. The content within the subsystem used to describe each element makes the individual subsystems unique and discrete. The unique input to the communication subsystem is *information*. The transforming processes are grouped into graphic and electronic processes that are used to convert information into a form that can be received and/or used by the intended audience. Construction and manufacturing (production) subsystems use processes to transform *materials* into outputs. Outputs from the construction subsystem are in the form of buildings, heavy industrial and civil structures that are built at site. The outputs from the manufacturing subsystem are distributed products. The primary input into the transportation subsystem is *energy*. This energy is transformed by vehicles and support systems into outputs which consist of relocated goods, people, and services. A biotechnology subsystem uses *living organisms* as unique inputs and biological processes to produce outputs of food, chemicals, and services.

Students' understanding of the economic context for the subsystems is often achieved by staging learning experiences in simulated industrial settings such as a manufacturing enterprise, contracting or architectural engineering firm, recording studio, or publishing house. The organization of management and management technology are used in experiential learning activities in ways that allow students to roleplay the general duties and working conditions of industrial personnel.

Currently, the thrust of the content and activities is on helping students understand inputs, processes, and outputs of present-day technical subsystems used in contemporary industry. The second thrust is less concerned with describing existing structures of technological subsystems and more concerned about understanding systems theory and how to use system models to analyze problems and technological activity. The second approach seems to pay greater attention to analyzing and adapting existing systems, and to creating new systems for the purposes of liberating people, enhancing the quality of life, and projecting and controlling the impact of technology on people and the environment. Simulation and problem-centered activities are used to help students develop higher-level thinking skills of analysis, problem solving, and decision making.

The use of direct and purposeful experiences is a recommended vehicle of instruction. Whenever possible, students and student groups should work on real problems such as role-playing community planners and generating alternatives for a neighborhood revitalization project, serve as an architectural firm and design a structure for a local person or agency, or form and operate an enterprise.

Content in the Technical Competency Element

A. Universal Systems
   1. Definition
      a. Kinds
         i. Open loop
         ii. Closed loop
      b. Components
         i. Input (specifications, resources [people, knowledge, material, energy, capital, time])
         ii. Process (productive, managerial)
         iii. Output (desired-undesired, expected-unexpected)
         iv. Feedback (control, evaluation)
      c. Types
         i. Natural
         ii. Human made
      d. Uses
         i. Analyze existing systems
         ii. Adapt existing systems
         iii. Create new systems
   2. Impacts
      a. On individuals - examples
         i. Liberating force
         ii. Unemployment
      b. On society - examples
         i. Greater social responsibility
         ii. Dependency on technology
      c. On environment - examples
         i. Pollution
         ii. Disrupt the function of natural systems
      d. On economy - examples
         i. Higher standard of living
         ii. Depleted resources
   3. Limits - examples
      a. Laws of nature
      b. Lack of knowledge
      c. Lack of technologies
      d. Lack of resources
      e. Social attitudes and acceptance
   4. Goals - examples
      a. Higher standard of living
      b. Achieve technological harmony with people and environment
      c. Improve quality of life

B. Technical Systems
   1. Biotechnology: biological processes used to produce products and services
      a. Scope
         i. Agricultural
         ii. Medical
         iii. Antibody production
         iv. Bioprocessing
         v. Genetic engineering
         vi. Bioenergy/fuel
      b. Universal systems model
         i. Inputs (specifications, resources)
         ii. Productive processes (food production, bioenergy fermentation, biotechnical - chemical, enzyme)
         iii. Managerial processes (plan, organize, direct, control)
         iv. Outputs (food, fuel, chemicals, controls, materials)
      c. Managed system
         i. Establish/identify needs
         ii. Design research
         iii. Develop industries
         iv. Produce output
         v. Regulate results
         vi. Disseminate the developments
      d. Impacts
         i. On individuals
         ii. On society
         iii. On the environment
         iv. On the economy
   2. Communication: transferring and/or processing ideas and information
      a. Scope
         i. Audio
         ii. Visual
         iii. Audio/Visual
      b. Universal systems model
         i. Inputs (specifications, resources)
         ii. Productive processes (transmitting, encoding, receiving, decoding, feedback, storing, retrieving)
         iii. Managerial processes (plan, organize, direct, control)
         iv. Outputs (instruction, information, entertainment, feedback)
      c. Managed system
         i. Establish the organization
         ii. Design the message
         iii. Prepare to transmit the message
         iv. Transmit the message
         v. Retrieve the message
         vi. Control the system
      d. Impacts
         i. On individuals

ii. On society
iii. On the environment
iv. On the economy

3. Construction: building structures at a site
   a. Scope
      i. Buildings
      ii. Civil structures
      iii. Heavy industrial structures
   b. Universal systems model
      i. Inputs (specifications, resources)
      ii. Productive processes (prepare to build, set foundations, build superstructures, install mechanical system, enclose superstructure, finish project, complete site, service project)
      iii. Managerial processes
      iv. Outputs (buildings, heavy industrial structures, civil structures)
   c. Managed system
      i. Establish the organization
      ii. Design the structure
      iii. Prepare to build the structure
      iv. Build the structure
      v. Transfer ownership
      vi. Control the system
   d. Impacts
      i. On individuals
      ii. On society
      iii. On the environment
      iv. On the economy
4. Manufacturing: producing, distributing, and servicing products
   a. Scope
      i. Raw material production
      ii. Industrial material production
      iii. Consumer goods production
      iv. Service
   b. Universal systems model
      i. Inputs (specifications, resources)
      ii. Productive processes (obtain materials, produce standard stock, produce goods, distribute, service)
      iii. Managerial processes
      iv. Outputs (standard stock, finished products)
   c. Managed system
      i. Establish the organization
      ii. Design the product
      iii. Prepare to produce the product
      iv. Produce the product
      v. Package the product
      vi. Deliver the product
      vii. Service the product
   d. Impacts
      i. On individuals
      ii. On society
      iii. On the environment
      iv. On the economy
5. Transportation: relocating goods, materials, and services
   a. Scope
      i. Land
      ii. Water
      iii. Air
      iv. Space
   b. Universal systems model
      i. Inputs (specifications, resources)
      ii. Productive processes (receive, hold, transport, unload, deliver)
      iii. Managerial processes (Plan, organize, direct, control)
      iv. Outputs (place utility of people, goods, services)
   c. Managed system
      i. Establish system
      ii. Design system
      iii. Prepare to transport
      iv. Transport
      v. Arrive at new location
      vi. Deliver
      vii. Control the system
   d. Vehicular (on-board) subsystem
      i. Propulsion (energy converters, transmission, drive)
      ii. Suspension (mechanical, fluid, magnetic)
      iii. Control (actuating, arresting)
      iv. Guidance (information, guideway)
      v. Vehicular structures
   e. Support (off-board) subsystems (fixed structures, services)
   f. Impacts
      i. On individuals
      ii. On society
      iii. On the environment
      iv. On the economy

Structure of Courses for Technical Competency Element

The recommended program consists of 54 semester hours of credit. Of the 54 credit hours, six are used to develop professional education competencies and are described later. The remaining 48 credit hours are used to develop technical competencies. The courses are sequenced from general to specific. Broad comprehensive courses are offered at the 100 level. Courses offered at the 200 and 300 levels are comprised of specialization and skill development courses in each cluster. Specialization courses provide opportunities for students to apply concepts, principles, and processes to solve significant problems. Recommendations for course titles and descriptions for each level follow.

100 Level Courses (18 semester hours)

INTRODUCTION TO TECHNOLOGY:
(3 semester hours)

This course introduces students to the development of technology and the elements of technological systems. Emphasis is placed on the associated technologies and impacts of and interrelationships among biotechnology, communications, construction, manufacturing, and transportation.

INTRODUCTION TO DESIGN PROCESSES: (3 semester hours)

Design theories are introduced. Students learn systems modeling, problem solving, and decision making technology. Design communication and documentation techniques are applied to 2 and 3 dimensional objects and products.

BIOTECHNOLOGY SYSTEMS:
(3 semester hours)

A study of the genetic engineering, bioprocessing, and antibody production technologies. The focus is on inputs, productive processes, outputs, and impacts on people, the environment, and the quality of life.

INTRODUCTION TO COMMUNICATION SYSTEMS: (3 semester hours)

Students are introduced to the systems and the techniques used to communicate ideas, knowledge and information with emphasis on the impacts of communication on individuals and society.

INTRODUCTION TO CONSTRUCTION SYSTEMS: (3 semester hours)

The focus of the course is on practices used in the construction industry to convert a want or a need of an owner into a completed and operating structure. The interrelationship to societal institutions, the environment, and the quality of life are introduced.

INTRODUCTION TO MANUFACTURING SYSTEMS: (3 semester hours)

This course addresses concepts, processes, and practices used to convert needs and wants of consumers into distributed products, and the interrelationship of people, the environment, and quality of life.

INTRODUCTION TO TRANSPORTATION SYSTEMS: (3 semester hours)

Students are introduced to concepts and practices used in a transportation system to move people and distribute goods.

200/300 Level Courses (21 semester hours - "Material Processing Systems" is required.)

MATERIAL PROCESSING SYSTEMS:
(3 semester hours)

An introduction to properties of industrial materials and processes used to produce standard stock and finished products. Provides experiences necessary to develop essential competencies required to perform common manufacturing processes with ceramic, metallic, and composite materials.

DESIGNING PRODUCTS AND PRODUCTION SYSTEMS:
(3 semester hours)

The emphasis of this course is on practices used to develop, engineer, and specify manufactured products and the systems used to produce them.

BIOPROCESSING TECHNOLOGY:
(3 semester hours)

A study of biotechnological systems used to produce food, fuels, antibodies, chemicals, and materials; of the management of the systems; and of their impacts on people and the environment.

DESIGNING BIOTECHNOLOGICAL SYSTEMS: (3 semester hours)

The design of biotechnological systems that meet design criteria, specifications, and users needs.

GRAPHIC COMMUNICATION SYSTEMS:
(3 semester hours)

An overview of the graphic communication system. Processes used to produce printed and photographic communication products are emphasized.

ELECTRONIC COMMUNICATION SYSTEMS: (3 semester hours)
Electronic communication systems utilizing hard-wired, computer, light, and acoustic communication systems are studied.

DESIGNING AND ENGINEERING STRUCTURES: (3 semester hours)
Students learn contemporary design practices and principles used to analyze and select sites, design and engineer structures, estimate costs, prepare construction documents, and administer construction projects.

CONSTRUCTING STRUCTURES TECHNOLOGY: (3 semester hours)
Students study practices used by contractors and construction managers to construct structures from a set of approved construction documents. Emphasis is placed on estimating and bidding, scheduling, and construction processes used to produce buildings, heavy industrial and civil structures.

ENERGY PROCESSING SYSTEMS: (3 semester hours)
Students use systems theory and modeling to analyze the inputs, processes, and outputs of energy systems. The emphasis of the course is on energy sources, conversion, and applications; and on the impacts of energy systems on people and the environment.

TRANSPORTATION SYSTEMS: (3 semester hours)
This course is a study of transportation systems used to move people and freight on land and water, and in air and space; and of their impact on people and the environment. Vehicular and support subsystems are emphasized.

400 Level Courses (9 semester hours selected from the following)

TECHNICAL EXPERIENCES IN MATERIAL PROCESSES: (3 semester hours)
Provides opportunities to develop advanced competencies in casting, molding, forming, separating, conditioning, assembling, and finishing processes.

APPROPRIATED BIOTECHNOLOGICAL SYSTEMS: (3 semester hours)
Students learn to blend biotechnology concepts and principles with those of appropriate technology to serve social purposes and to develop self-reliant neighborhoods and cultures.

DESIGNING TRANSPORTATION SYSTEMS: (3 semester hours)
Students are introduced to the design and operation of transportation systems and their impacts on society, individuals, the economy, and the environment.

MANUFACTURING ENTERPRISE: (3 semester hours)
This course focuses on management technology used to establish a manufacturing firm, develop and engineer a product and production system, finance the operation, and market the product.

COMMUNITY PLANNING: (3 semester hours)
Introduces students to activities involved in planning communities. Emphasis is placed on construction, demand, and site factors as they relate to developing housing, streets, transportation systems, parks, shopping areas, and recreational centers for public need.

MASS COMMUNICATIONS: (3 semester hours)
Students have the opportunity to design, plan, produce, and market communication media products.

CONTROLLING TECHNICAL SYSTEMS: (3 semester hours)
Students study kinds, elements, functions, and uses of controlling subsystems in technological systems. Students are presented a variety of challenging problems in which the design of one or more sophisticated control subsystems are required to solve the problem.

FUTURING TECHNOLOGY: (3 semester hours)
A study of concepts, design criteria, and processes used in developing appropriate technology and in assessing the long-term effects of technical innovations. In this course students learn futuring techniques used to describe alternative futures, study trends, assess technology, and prepare forecasts.

INTEGRATED SYSTEMS: (3 semester hours)
Technology used in two or more systems is brought to bear in solving complex problems resulting from the use of existing technology or from the introduction of new technology.

INTER-DISCIPLINARY STUDIES:
(3 semester hours)

Students study a technological innovation and the viewpoints and interrelationships between two or more disciplines. The methods that professionals from related fields use to discover and process knowledge are the major thrusts in this course.

A Closing Note to Curriculum Developers

The instructional methodology used in implementing the courses described above should include problem-centered activities in which the problems are as real as they are practical. Students should be placed in conditions where they need to function within the societal context from which the problems emanate. For example, have students solve management problems by managing broadcasting stations, manufacturing enterprises, design studios, and community planning offices in which students roleplay simulated or real-life situations. Opportunities for students to learn and use the methods professionals from related fields use to discover and process knowledge should be provided.

Chapter 4

Professional Education Element

The Changing Role of Technology Education Teachers

It is clear that the educational needs of our youth in the near future will need to be radically different. Becoming technologically literate will require higher and higher levels of education with greater and greater emphasis being placed on science and technology. The model that depicts the Professional Element is shown in Figure 6. In this proposal, Professional Education involves the achievement of eight broad goals by using instructional strategies to develop understandings of relevant unique concepts related to each goal. In the society facing the 21st century, where accelerating change may be the only constant, the ability to formulate problems, resolve issues, determine the most effective decisions, and create new solutions is a prerequisite for success in life. The goals, concepts, and instructional strategies recommended for the Professional Education Element are all directed toward producing Technology teachers who are learners and problem solvers rather than knowers.

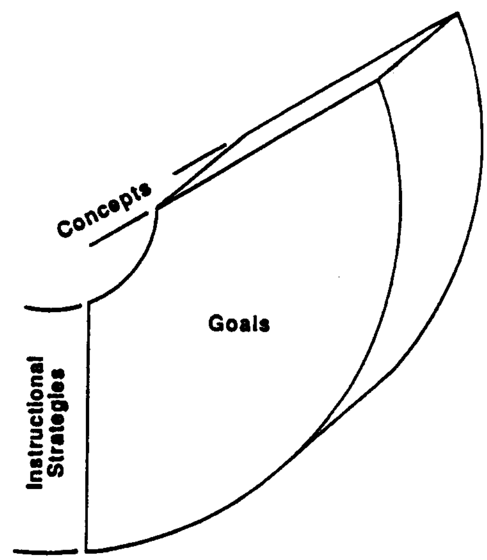

Figure 6. The Professional Education Element consists of Goals, Concepts, and Instructional Strategies.

In order for Technology to respond to the above conditions in an effective way, Technology teacher educators must make major changes in their programs and model those changes in their courses. These changes include the personalization of the knowledge and an application of the knowledge to solve "real" world problems. The authors of *Experiential and Simulation for Teaching Adults* (1986) stated:

> These methods (experiential learning methods) help to seal the bond between the learner and the learned in two ways: First by encouraging reflection on the meaning of abstract concepts in the light of shared personal experiences. The techniques allow concepts to become "real". . . . Second, by encouraging personal action on concepts, the techniques allow learners to commit themselves to the ideas. . . . Experiential learning technology offers even greater opportunities. By closing the loops between experience and concept, the technology allows learners to discover how to learn from their own experience and how to use their experiential learning capability to shape their own development. (p. 100)

In order to realize the full potential from experiential learning in Technology teacher education, implementers need to:

1. View students as active self-directed learners and treat them more like colleagues than as receivers of lectures, assignments, and grades.
2. Include in course content the processes used in technical systems to apply knowledge, discover new knowledge, solve problems, and make decisions.
3. Extend the purpose for technology to go beyond the awareness and understanding levels, and enter into the application and problem solving levels of thinking.
4. Create environments where students encounter more authentic problem-centered experiences in simulated or real industrial/environmental settings and apply the heuristic method practiced by professionals in the field.
5. Reduce individual and competitive learning environments and increase the use of collaborative group learning experiences in which heterogeneous teams are created, leadership is distributed, positive interdependence is present, and social skills are acquired within an autonomous group.
6. Change the structure and approach of Technology teacher education curricula from subject-based and teacher-directed to problem-based and student-directed, because teaching activity is not experienced as subjects. Instead, teaching activity consists of a series of problems that need to be solved.

Content in the Professional Education Element

The purpose of the Professional Education Element is to provide opportunities for prospective Technology Education teachers to develop a philosophy that is relevant to teaching Technology, skills in using instructional technology, a future orientation, a habit of lifelong learning, a positive self concept, and an ability to solve educational problems.

A. Develop Understanding of the Nature of Teaching
   1. Concept
      a. Characteristics of careers
      b. Characteristics of good teachers
      c. Introduce teaching Technology
      d. Introduce Philosophy of Teaching
      e. Industrial education terminology (Technology, industrial vocational education, technical education)
      f. Introduce concept of life-long learning
      g. Introduce concept of professionalism
   2. Instructional strategy
      a. Present characteristics of careers early
      b. Use problem-centered group activities
      c. Invite experienced teachers who are positive role models

B. Development of a Philosophy of Teaching
   1. Concepts
      a. Nature of students (needs, values, goals)
      b. Nature of society (trends, institutions, changing nature of society, needs of people)
      c. Nature of subject matter (terminology, structure, trends, history, impact of technology, curriculum development)
      d. Purposes of education (knowledge, utility, thinking skills, socialization)
      e. Learning theories (motivation, communication, organization)
   2. Instructional Strategy
      a. Subject scope and organization presented early
      b. Curriculum development process presented early
      c. Concepts reinforced throughout program
      d. Use problem-centered group activities
      e. Include student presentations
      f. Students periodically refine their views
      g. Focus on current societal needs

C. Use Instructional Technology
   1. Concepts
      a. Characteristics of the learner (physical, social, educational, emotional, intellectual)
      b. Intended outcomes (identification, communication)
      c. Instructional strategy (approach, sequence, techniques)
      d. Evaluation (purposes, procedures, domains)
      e. Physical environment (acquiring, managing)
      f. Social environment (cooperative classroom behavior, effective learning environment)
   2. Instructional strategy
      a. Basic knowledge developed early
      b. Teachers are role models who use theories
      c. Move from learning about theories to using theories

- d. Move from teacher-directed to student-directed
- e. Move from school-based to field-based activities
- f. Continues throughout preparation program

D. Develop Ability to Solve Educational Problems
1. Concepts - examples
   - a. Instructional
   - b. Professional
   - c. Financial
   - d. Future directions
   - e. Professional image
   - f. Curriculum
2. Instructional strategy
   - a. Problem-centered activities
   - b. Work in collaborative groups
   - c. Field-based settings
   - d. Student-directed activities

E. Contribute to Professional Organizations
1. Concepts
   - a. Being a member
   - b. Preparing presentations and publications
   - c. Providing leadership
   - d. Recruiting new members
2. Instructional strategy
   - a. Form student association (AIASA, TECA, other)
   - b. Participate in professional activities
   - c. Become active at local, state, and national levels

F. Develop a Future Orientation
1. Concepts - examples
   - a. Rationale for further studies
   - b. Concept of time, future, trend, forecasts, scenarios, and others
   - c. Historical perspective
   - d. Group process
   - e. Forecasting methods
   - f. Problem solving methods
   - g. Group opinion methods
   - h. Technological assessment models
   - i. Divergent thinking
2. Instructional strategy
   - a. Provide basic instruction on concepts and methods
   - b. Use challenging activities and facilitate success
   - c. Design future-oriented and problem solving activities

G. Develop a Habit of Interdependent Lifelong Learning
1. Concepts
   - a. Increase understanding of technology
   - b. Form mental structure for relevant knowledge
   - c. Refine a congruent personal theory
   - d. Increase effectiveness on group projects
   - e. Improve communication skills
   - f. Increase skills with new technology and equipment
   - g. Enlarge understanding of people and their nature
   - h. Gain more depth knowledge of learning theory
2. Instructional strategy
   - a. Use challenging activities and facilitate success
   - b. Be a good role model
   - c. Personally confront beliefs

H. Develop a Positive Self-Concept
1. Concepts
   - a. Positive view of self
   - b. An openness to experience and change
   - c. A sense of identification and belonging
   - d. A favorable view of students and others
2. Instructional strategy
   - a. Use challenging activities
   - b. Expect excellence
   - c. Facilitate success
   - d. Create growth-oriented atmosphere
   - e. Solve significant problems
   - f. Work in collaborative groups

Structure for the Professional Education Element

Instruction consists of leading students through learning experiences to help them grasp, transform, and transfer what is learned into personal meanings. There are usually several ways to structure content to facilitate learning for students. The optimum structure depends upon a variety of factors including past learning, stages of development, nature of the material, and individual differences.

Five principles useful in structuring learning experiences appear to have value to developers of Technology teacher education programs. The first principle is based on the feeling of need (Posner, 1986, p. 110-111). This principle leads one to schedule those units that seem to have the greatest student concern or are needed to provide focus early in the program. For example, instruction relating to working as a teacher in general and to teaching Technology in particular may be initiated early in a teacher preparation program to help future Technology teachers obtain a view of the roles they will play in the classroom. Research (Singer, 1974) indicates that when students' expectations about and potency in influencing their future increase, their motivation and sense of purpose also increase.

If problems, principles, or tasks of teachers have been organized into a conceptual structure, a second structuring principle is useful. Bruner's (1960) spiral curriculum theory suggests that students should progress from learning the basic elements of a structure early in the program and build on that structure throughout the remainder of the program. This theory would be used to help students develop personal theories, select and write curriculum materials, use instructional technology, and develop a plan for lifelong learning.

A third structuring principle is a logical structure in which a prospective teacher develops knowledge about a concept, skill, or value before applying, using, or accepting it. Lower level objectives, with behavioral teaching methods, should gradually give way to high level objectives where experiential learning technology is employed. The *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain* (Bloom, 1956) and *Experiential Learning* (Kolb, 1984) are two theories that suggest progressing from awareness levels through increasingly higher levels of thinking.

The fourth basis for structuring content is to plan instruction to increase independence (Henak & Barella, 1986, p. 166). As prospective teachers draw closer to their first teaching position, it becomes increasingly imperative that they develop the capacity to exhibit constructive forms of teacher behavior with a minimum of supervision. The first application of this principle relates to student-directed versus teacher-directed experiences. As students mature, learn, and approach the time when they work with a minimum of supervision, they should receive progressively less supervision from faculty. Hence, teacher education should become increasingly student-directed. A second way to help students become independent and in charge of their own growth is to have them work in field-based settings as they progress through the program.

RECOMMENDED PROFESSIONAL EDUCATION STRUCTURE
(29 credit hours recommended)

Supervised by the department, college, or school of education - 29 credits

Child Growth and Development*	3 credits
Educational Psychology*	3 credits
Reading*	3 credits
Social Foundations of Education*	3 credits
Classroom Management*	3 credits
General Methodology*	3 credits
Special methodology in subject*	3 credits
Student Teaching*	3 credits

Taught and supervised by major department*** - 6 credits

Exploring Technology Education	3 credits
Curriculum Development in Technology Education	3 credits

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* Taught in a department, college, or school of education
** Taught or supervised in the major department - credit assigned to Professional Element
*** Credit assigned to Technical Competency Element

Finally, the fifth principle directs the program developer to provide early and continuing field experiences (Henak & Barella, 1986, p. 166) in teacher preparation programs. Learning environments in elementary, middle, and high school settings where prospective teachers encounter authentic problem-centered experiences, and where prospective teachers practice solving significant educational problems while working with professionals in the field are two essential ingredients of Technology teacher preparation programs.

Our world is no longer dominated by the rugged individualist. In place of individual effort, curriculum development teams are recommended. Some characteristics of these teams are that consensus decision making (rather than voting) is used to reach closure, each person is expected to contribute, the curriculum resulting from the group effort is comprehensive, articulated and based on a contemporary philosophy, and all members enjoy the benefits from the group work. If developing effective team members and productive groups are goals of Technology teacher education programs, then the methods used in courses need to simulate teaching conditions and settings selected that facilitate productive curriculum development.

Courses in the Professional Education Element

Courses in the Professional Education Element are typically taught in both the major department and in a department, college, or school of education. Content relating to child growth and development, educational psychology, reading, social foundations, student teaching, and use of instructional media are usually taught outside the major department. Since in the major department, program developers have little control over these courses, the structure of the courses and their content is not described. Courses to be taught in the major department follow.

<u>100 or 200 Level Course</u> (3 semester hours)

TEACHING TECHNOLOGY: (3 semester hours)
Students work individually and in collaborative groups to investigate a career in teaching Technology, begin developing a philosophy of teaching relevant to Technology, and gain an understanding of the historic development, terminology, and curriculum development processes in Technology.

1. Describing a career in teaching Technology.
2. History of Technology.
3. Differentiating terminology in the field of Technology.
4. Developing a Philosophy of Teaching.
5. Describing curriculum development processes used in Technology.

<u>300 Level Course</u> (5 semester hours)

METHODS FOR TEACHING TECHNOLOGY: (5 semester hours 300 level)
Problems in developing and implementing instructional strategies, preparing evaluation instruments, managing the physical environment, and maintaining a cooperative classroom environment. Topics developed in the context of field experiences whenever possible.

NOTE: This course should be taught in the major department with the credit hours used to satisfy the professional requirements.

1. Describing the characteristics of a group of learners.
2. Communicating the rationale, objectives, structure, and intended outcomes for a Technology course.
3. Developing an instructional strategy for teaching problem solving through a problem solving approach in which technical content and activities are emphasized.
4. Designing an evaluation system for a Technology course.
5. Designing and managing the physical environment for a Technology course.
6. Managing classroom behavior.
7. Producing instructional media.
8. Teaching value/moral issues within a Technology context.
9. Teaching futuristics in the Technology classroom.
10. Teaching students with special needs.
11. Developing and implementing a safety program in Technology laboratories.

<u>400 Level Courses</u> (10 semester hours)

CURRICULUM DEVELOPMENT IN TECHNOLOGY: (3 semester hours 400 level)
Emphasizes contemporary approaches to Technology, curriculum development, and the preparation and use of instructional media. Students plan and execute a teaching unit in a public school setting.

1. Developing criteria for evaluating Technology curriculum materials.
2. Evaluating and selecting instructional units in Technology.
3. Developing and implementing instructional units in Technology.
4. Preparing and using instructional media.

STUDENT TEACHING: (7 semester hours)

Involves full-day assignment for seven to ten weeks in public school setting under the supervision of Technology Teacher Education faculty who have have teaching experience and have maintained close involvement with teaching Technology in the public schools.

Summary

Attention was given to the profound social, economic, and environmental changes that have resulted from the growth of information and its application to the invention and utilization of technology. It is clear that we are at a turning point in civilization. Economic, political, and environmental concerns are no longer individual or even national concerns; they are world concerns. Much of what we have done to arrive at the present standard of living and quality of life seems inappropriate for the remainder of this century and for those beyond. Our motivation for technological invention must come from deeper levels of responsibility than the motives of obtaining economic efficiency or gaining a competitive advantage. People involved in inventing and using technology in the future will need to understand it and respond to it with keen insights into social purpose and good stewardship of natural resources and environment, and into personal fulfillment and social order. There will need to be a greater understanding of our social, technological, and ecological systems and how they interrelate and contribute to an improved quality of life.

If we, and future generations, are to exhibit responsible behavior, we must educate ourselves in ways that develop an appropriate belief system and knowledge of appropriate alternatives. Major changes in our perception of content, structure, and methods of instruction must occur in Technology programs; and, especially in pre-service and in-service programs used to prepare teachers. As a minimum, consideration must be given to:

1. The study of the behavior, interrelationships, and control of social, technical, and environmental systems.
2. The use of problem solving, change, decision making, valuing, and futuring.
3. The development of skills of anticipation of future conditions, design and assessment of new and alternative technologies, and technological systems for the future.
4. The appreciation of humankind, social purpose, stability of the ecosphere, self-reliance, and quality of life.

The design of the new curriculum must include new instructional strategies that are based on the most current research, communication processes, and instructional systems.

The intent of the writers was to make recommendations for the elements and structure for a model Technology teacher education program that is:

1. Consistent with the characteristics of learners.
2. Responsive to trends and demands of a changing society.
3. Representative of the best thinking at this time regarding technological subject matter and its structure.
4. Focused on purpose(s) of education for citizens in a world community.
5. Based on sound learning theory.

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