TECHNOLOGY EDUCATION FOR THE 21ST CENTURY

Editor
E. Eugene Martin

49th Yearbook

Council on Technology Teacher Education

2000

TECHNOLOGY EDUCATION FOR THE 21ST CENTURY A COLLECTION OF ESSAYS

Editor
G. Eugene Martin
Southwest Texas State University

49th Yearbook, 2000

Council on Technology Teacher Education

Glencoe McGraw-Hill

New York, New York Columbus, Ohio Mission Hills, California Peoria, Illinois

Glencoe/McGraw-Hill

A Division of The McGraw-Hill Companies

Send all inquiries to:
Glencoe/McGraw-Hill
3008 W. Willow Knolls Drive
Peoria, IL 61614

ISBN 0-07-821985-X

Printed in the United States of America.

1 2 3 4 5 6 7 8 9 10 026 04 03 02 01 00

Orders and requests for information about cost and availability of yearbooks should be directed to Glencoe/McGraw-Hill's Order Department, 1-800-334-7344.

Requests to quote portions of yearbooks should be addressed to the Secretary, Council on Technology Teacher Education, in care of Glencoe McGraw-Hill at the above address, for forwarding to the current Secretary.

This publication is available in microfilm.

University Microfilms International
300 North Zeeb Road
Dept. P.R. Ann Arbor, MI 48106

FOREWORD

The decades of the 20th century have provided much new technology resulting in higher standards of living and improved means of education. Although so much new technology was created during that century, e.g., aviation-powered flight, transatlantic flight, walking on the moon and circumnavigating the globe by balloon, most were looking at the new millennium with renewed anticipation, particularly for technological innovation and discovery. Although 1999 was a year in history, it appeared that the media was pushing it out of the way and a countdown was begun for 2000.

In technology education, enormous changes also occurred during the 20th century. Many variations of this school subject appeared, e.g., unit laboratories, the systems approach to technological laboratories, and more students than ever enrolled in technological studies as we approached 2000. A guiding force for teacher education was created in 1950. Today the Council on Technology Teacher Education is providing its 49th yearbook, a yearbook that is directed toward the future of technology education. It asks questions about our subject area.

1. Will the new century produce new content and methods for the study of technology?
2. Will technological studies become part of the core academic curriculum?
3. Will our research prove that the citizens of the 21st century need to study technology education so they can become better prepared for life?
4. What will be the exemplary practices of technology education in the 21st century?
5. What will be technology education's professional and political agendas?
6. How will the study of technology differ than that which was recorded during the 20th century?

Through the insight of the yearbook's editor, Dr. G. Eugene Martin, and its authors, you will be provided snapshots of the future. In future yearbooks, the historians of our profession will reflect on this yearbook and indicate how accurate the perceptions of our leaders were as we began to educate for the 21st century.

John M. Ritz
CTTE President

YEARBOOK PLANNING COMMITTEE

Terms Expiring 2000

Rodney L. Custer
Illinois State University
Michael L. Scott
The Ohio State University

Terms Expiring 2001

Anthony E. Schwaller
St. Cloud State University
Donna K. Trautman
Bowling Green State University

Terms Expiring 2002

Karen F. Zuga
The Ohio State University
G. Eugene Martin
Southwest Texas State University

Terms Expiring 2003

Linda Rae Markert
State University of New York-Oswego
John R. Wright
Central Connecticut State University

Terms Expiring 2004

Cyril King
South Eastern Education and Library Board
Peter H. Wright
Indiana State University

OFFICERS OF THE COUNCIL

President
John M. Ritz
Old Dominion University
Occupational & Technical Studies
Norfolk, VA 23529-0498

Vice-President
Mark E. Sanders
Virginia Tech
Technology Education
Blacksburg, VA 24061-0432

Secretary
Sharon A. Brusic
Virginia Tech
Technology Education
Blacksburg, VA 24061-0432

Treasurer
Charles A. Pinder
Northern Kentucky University
Department of Technology
Highland Heights, KY 41099

Past President
Everett N. Israel
Illinois State University
Department of Industrial Technology
Normal, IL 61790

YEARBOOK PROPOSALS

Each year at the ITEA International Conference, the CTTE Yearbook Committee reviews the progress of yearbooks in preparation and evaluates proposals for additional yearbooks. Any member is welcome to submit a yearbook proposal, which should be written in sufficient detail for the committee to be able to understand the proposed substance and format. Fifteen copies of the proposal should be sent to the committee chairperson by February 1 of the year in which the conference is held. Below are the criteria employed by the committee in making yearbook selections.

CTTE Yearbook Committee

CTTE Yearbook Guidelines

A. Purpose

The CTTE Yearbook Series is intended as a vehicle for communicating major topics or issues related to technology teacher education in a structured, formal series that does not duplicate commercial textbook publishing activities.

B. Yearbook topic selection criteria

An appropriate yearbook topic should:

1. Make a direct contribution to the understanding and improvement of technology teacher education;
2. Add to the accumulated body of knowledge of technology teacher education and to the field of technology education;
3. Not duplicate publishing activities of other professional groups;
4. Provide a balanced view of the theme and not promote a single individual's or institution's philosophy or practices;
5. Actively seek to upgrade and modernize professional practice in technology teacher education; and,
6. Lend itself to team authorship as opposed to single authorship.

Proper yearbook themes related to technology teacher education may also be structured to:

1. Discuss and critique points of view that have gained a degree of acceptance by the profession;
2. Raise controversial questions in an effort to obtain a national hearing; and,
3. Consider and evaluate a variety of seemingly conflicting trends and statements emanating from several sources.

C. The Yearbook Proposal

1. The yearbook proposal should provide adequate detail for the Yearbook Committee to evaluate its merits.
2. The yearbook proposal includes the following elements:
   a) Defines and describes the topic of the yearbook;
   b) Identifies the theme and describes the rationale for the theme;
   c) Identifies the need for the yearbook and the potential audience or audiences;
   d) Explains how the yearbook will advance the technology teacher education profession and technology education in general;
   e) Diagram symbolically the intent of the yearbook;
   f) An outline of the yearbook which includes:
      i) A table of contents;
      ii) A brief description of the content or purpose of each chapter;
      iii) At least a three level outline for each chapter;
      iv) Identification of chapter authors(s) and backup authors;
      v) An estimated number of pages for each yearbook chapter; and,
      vi) An estimated number of pages for the yearbook (not to exceed 250 pages).
   g) A timeline for completing the yearbook.

It is understood that each author of a yearbook proposal will sign a CTTE Editor/Author Agreement and comply with the Agreement.

PREVIOUSLY PUBLISHED YEARBOOKS

*1. *Inventory Analysis of Industrial Arts Teacher Education Facilities, Personnel and Programs,* 1952.
*2. *Who's Who in Industrial Arts Teacher Education,* 1953.
*3. *Some Components of Current Leadership: Techniques of Selection and Guidance of Graduate Students; An Analysis of Textbook Emphases;* 1954, three studies.
*4. *Superior Practices in Industrial Arts Teacher Education,* 1955.
*5. *Problems and Issues in Industrial Arts Teacher Education,* 1956.
*6. *A Sourcebook of Reading in Education for Use in Industrial Arts and Industrial Arts Teacher Education,* 1957.
*7. *The Accreditation of Industrial Arts Teacher Education,* 1958.
*8. *Planning Industrial Arts Facilities,* 1959. Ralph K. Nair, ed.
*9. *Research in Industrial Arts Education,* 1960. Raymond Van Tassel, ed.
*10. *Graduate Study in Industrial Arts,* 1961. R. P. Norman and R. C. Bohn, eds.
*11. *Essentials of Preservice Preparation,* 1962. Donald G. Lux, ed.
*12. *Action and Thought in Industrial Arts Education,* 1963. E. A. T. Svendsen, ed.
*13. *Classroom Research in Industrial Arts,* 1964. Charles B. Porter, ed.
*14. *Approaches and Procedures in Industrial Arts,* 1965. G. S. Wall, ed.
*15. *Status of Research in Industrial Arts,* 1966. John D. Rowlett, ed.
*16. *Evaluation Guidelines for Contemporary Industrial Arts Programs,* 1967. Lloyd P. Nelson and William T. Sargent, eds.
*17. *A Historical Perspective of Industry,* 1968. Joseph F. Luetkemeyer Jr., ed.
*18. *Industrial Technology Education,* 1969. C. Thomas Dean and N. A. Hauer, eds.; *Who's Who in Industrial Arts Teacher Education,* 1969. John M. Pollock and Charles A. Bunten, eds.
*19. *Industrial Arts for Disadvantaged Youth,* 1970. Ralph O. Gallington, ed.
*20. *Components of Teacher Education,* 1971. W. E. Ray and J. Streichler, eds.
*21. *Industrial Arts for the Early Adolescent,* 1972. Daniel J. Householder, ed.
*22. *Industrial Arts in Senior High Schools,* 1973. Rutherford E. Lockette, ed.
*23. *Industrial Arts for the Elementary School,* 1974. Robert G. Thrower and Robert D. Weber, eds.
*24. *A Guide to the Planning of Industrial Arts Facilities,* 1975. D. E. Moon, ed.
*25. *Future Alternatives for Industrial Arts,* 1976. Lee H. Smalley, ed.
*26. *Competency-Based Industrial Arts Teacher Education,* 1977. Jack C. Brueckman and Stanley E. Brooks, eds.
*27. *Industrial Arts in the Open Access Curriculum,* 1978. L. D. Anderson, ed.
*28. *Industrial Arts Education: Retrospect, Prospect,* 1979. G. Eugene Martin, ed.
*29. *Technology and Society: Interfaces with Industrial Arts,* 1980. Herbert A. Anderson and M. James Benson, eds.
*30. *An Interpretive History of Industrial Arts,* 1981. Richard Barella and Thomas Wright, eds.
*31. *The Contributions of Industrial Arts to Selected Areas of Education,* 1982. Donald Maley and Kendall N. Starkweather, eds.
*32. *The Dynamics of Creative Leadership for Industrial Arts Education,* 1983. Robert E. Wenig and John I. Mathews, eds.
*33. *Affective Learning in Industrial Arts,* 1984. Gerald L. Jennings, ed.
*34. *Perceptual and Psychomotor Learning in Industrial Arts Education,* 1985. John M. Shemick, ed.

*35. *Implementing Technology Education*, 1986. Ronald E. Jones and John R. Wright, eds.
*36. *Conducting Technical Research*, 1987. Everett N. Israel and R. Thomas Wright, eds.
*37. *Instructional Strategies for Technology Education*, 1988. William H. Kemp and Anthony E. Schwaller, eds.
38. *Technology Student Organizations*, 1989. M. Roger Betts and Arvid W. Van Dyke, eds.
39. *Communication in Technology Education*, 1990. Jane A. Liedtke, ed.
40. *Technological Literacy*, 1991. Michael J. Dyrenfurth and Michael R. Kozak, eds.
41. *Transportation in Technology Education*, 1992. John R. Wright and Stanley Komacek, eds.
42. *Manufacturing in Technology Education*, 1993. Richard D. Seymour and Ray L. Shackelford, eds.
43. *Construction in Technology Education*, 1994. Jack W. Wescott and Richard M. Henak, eds.
44. *Foundations of Technology Education*, 1995. G. Eugene Martin, ed.
45. *Technology and the Quality of Life*, 1996. Rodney L. Custer and A. Emerson Wiens, eds.
46. *Elementary School Technology Education*, 1997. James J. Kirkwood and Patrick N. Foster, eds.
47. *Diversity in Technology Education*, 1998. Betty L. Rider, ed.
48. *Advancing Professionalism in Technology Education*, 1999. Anthony F. Gilberti and David L. Rouch, eds.
49. *Technology Education for the 21st Century A Collection of Essays*, 2000. G. Eugene Martin, ed.

---

*Out-of-print yearbooks can be obtained in microfilm and in Xerox copies. For information on price and delivery, write to Xerox University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan, 48106.

CONTENTS

PREFACE

This yearbook, the 49th in a distinguished series of yearbooks, is something special. Yet, there is nothing magical in how it all came about. The idea to develop a yearbook for the year 2000 was a challenge from the outset, and to do something different for the new millennium simply fascinated me.

In the early stages of its development, I decided the yearbook would provide a forum for a distinguished group of individuals to speak from their hearts through their written words. If all else failed, I wanted their personal feelings to come across to the reader. Short essays would be the format to convey their messages.

Unlike other yearbook proposals that have been submitted to the Council on Technology Teacher Education, the proposal for this yearbook was unstructured. While I identified the four main units and some potential authors in my yearbook proposal, nothing else was identified or developed. I invited individuals to submit proposals for review by an independent group of professionals who, ultimately, made their recommendations to me. Approximately 75 people responded to my invitation by submitting proposals and 37 individuals were selected to participate in the development of the yearbook. I made the final decision on the selection of essays and authors—I accept full responsibility. The content of this yearbook was thus born.

The goals of this yearbook are several: (a) allow individuals to communicate their positions on topics of special interest to them personally; (b) provide a forum to raise issues, ask questions, and make statements; (c) celebrate the successes of our profession through the identification of our exemplary practices; and (d) identify agenda topics for technology education in the 21st century. I believe the authors have done an exemplary job in addressing the goals—and I hope you agree also.

G. Eugene Martin
Editor

ACKNOWLEDGMENTS

The development of a CTTE yearbook is no easy task. In addition to all the work involved in the proposal development process, many hours are spent communicating with authors and reviewing their manuscripts. Obviously, a yearbook would never come to fruition without the dedication of the authors. I was blessed to have the opportunity to work with outstanding individuals in writing the essays for this yearbook.

The CTTE officers, past and present, were very supportive in the yearbook's development. They closely monitored the yearbook's progress, provided me encouragement, and promptly responded to my questions. I thank each of them for their support.

The faculty, staff, and administration at Southwest Texas State University were also supportive of my efforts. Martha Bird, my Administrative Assistant, provided invaluable assistance throughout the development of the yearbook.

No yearbook would be possible without family support and encouragement. My wife, Glenda, and our son, Christopher, have been supportive of all my professional endeavors, and I thank them dearly. Their encouragement was just as strong with this yearbook as it was when I edited the 28th and 44th yearbooks.

As you can readily conclude, many individuals made this yearbook possible and they deserve much of the credit for bringing it to reality. Please thank them the next time you see them.

G. Eugene Martin
Editor

Unit I

EVOLVING INTO THE 21ST CENTURY

Essay 1

The Past Defines the Paths to be Taken

Jerry Streichler
Bowling Green State University, Ohio
Epsilon Pi Tau, La Jolla, California

It's astonishing what can happen when you look into the future without forgetting the past. (Cadillac EVOQ Concept Car advertisement, The Wall Street Journal, January 29, 1999, p. A11)

Writing this lead-in essay was a challenging and arduous task. The editor's charge was for me to try to make sense out of the major issues (note I did not say events) which occurred during my professional career. Hopefully, my reflections and to some degree my admonitions and prognostications provide a foundation for the exemplary practices and future agenda sections which comprise the body of this yearbook. At the very least, I hope they cause you to reconsider some of the long held positions in our profession and identify new and different approaches and strategies that leaders ought to strongly consider and act upon. My perspectives are intended to be useful to those who will determine and to those who will follow the paths the profession will take in the coming millennium.

Ending the Dichotomies

For almost a century, our field has been wracked by strong, almost violent disagreements about its nature, purpose, and objectives. On balance, the disagreements have been a major waste of time and talent. During my time in the profession, one disagreement stands out above all others—our field's obsession with its connection to vocational education. Even today, some influential technology education leaders declare that we must not identify with vocational education, but only with academic subjects. Ironically, there is evidence that leaders of those academic subjects are embracing vocational or prevocational values. Can we free ourselves of dichotomous feelings that exist? Are there messages to be learned from our past? The following paragraphs provide a brief overview of the dichotomies and may indeed be the source for answers to these questions.

It is important to note that in the presence of seemingly strong anti-vocational feelings throughout our history, vocational funds were used to advance our field. In the 1960s, for example, significant philosophical differences on the role of industrial arts existed among leaders in our profession. There is no better example than the differences that existed between Robert M. Worthington and Rutherford E. Lockette of Trenton State College on the one hand and Carl E. Frankson and Arthur W. Earl of Montclair State College on the other. Worthington and Lockette were said to have favored a more vocational or prevocational emphasis for industrial arts and the use of large unit laboratories to teach special technical areas. In contrast, Frankson and Earl emphasized the blending of areas around creative and problem solving endeavors and the representation of industrial processes and organization in large open areas, which allowed open flow among technical specialties. Yet, when Worthington was appointed the New Jersey Associate Commissioner of Vocational Education, he was most creative in the use of vocational funds to support public school industrial arts. He literally saved a number of vegetating programs by funding new equipment and facilities improvement while making no judgments about their philosophical approach. Worthington and Lockette also worked to obtain vocational and private foundation funds for Elizabeth Hunt's Technology For Children curriculum. Hunt's curriculum was rooted in an almost pure Deweyesque interdisciplinary learning to learn, discovery, and problem solving, overlaid upon a basic skills (reading, writing, arithmetic, social studies, and technology) program. Finally, the Worthington/Lockette vision led to a rationale that a bachelor's degree program to prepare industrial technologists for industry would provide incentives for students in high school vocational programs and technical college programs. These leaders, like others across the country at the time, had strong philosophical positions, but were more likely to be guided by larger motives to improve conditions in schooling and they did not allow differences in approaches to stand in the way of the help they could provide.

At about the same time, the Vocational Education Act of 1963 funded the Industrial Arts Curriculum Project at The Ohio State University. In my opinion, it was the most compelling of the several thoughtful and innovative conceptualizations of the 1960s and 1970s. This non-vocational focused project was the most generously funded industrial arts project up to its time and it was done with vocational funds. From the same campus and during this same time frame, the first *Review and Synthesis of Research in Industrial Arts* in our field, which I had the privilege of writing, was published and disseminated by the federal vocational funds-supported Center for Vocational and Technical Education.

Our fields' embrace of science and mathematics has more than a touch of irony. We need to realize that leaders of the National Science Foundation (NSF) may not at all be concerned with the distinctions we have drawn between our field and vocational education. I have heard NSF directors use the Foundation's term "Advanced Technology Education" to refer to post-secondary technical education, which is clearly vocational education. The engineering profession's interest in technology education has both general literacy and prevocational connotations as engineers are motivated, in part, by the hope that the development of interest in engineering in the lower school grades will provide a superior pool of students to pursue professional training. Finally, it appears to be consummately naive of some of our influential leaders to continue to advocate a complete and final separation from vocational education and to establish the field as an academic subject like mathematics and science, when leaders of those fields have taken seriously the pronouncements from the federal government that suggest that virtually all education should have a vocational flavor.

There is the possibility of a different sort of dichotomy emerging out of science leaders' embrace of the objective of teaching technology and their apparent current willingness to accept technology education as the vehicle to accomplish that goal. The interesting and creative curriculum relationships in mathematics, science, and technology (MST) and science, technology, and society (STS) studies may yield another avenue of differences. While these relationships are undoubtedly meritorious, there are members of the technology field who are either concerned about or outright reject such interdisciplinary associations. They may well have the quote in mind, "It's like wrestling with a gorilla," which originally referred to vocational education, but now it focuses on the politically strong science and mathematics organizations. Their thoughts may also be colored by what happened to many technology education programs during the budget crunches of the early 1990s. Should the cycle repeat, what will be the position of the more powerful and numerous educators in the other fields? Will they fight beside us to maintain the technology programs, or will they take the road to doing it themselves as they sacrifice their colleagues in technology?

Is this stuff threatening? It is, if we go it alone. However, there is much that is instructive and much that is positive in the situation. First of all, we ought to take pride and continually remind the world that we have been ahead of the game in innovative instruction and curriculum conceptualizations that capitalized on physical activity as a primary element of the learning process. One can find methods that we initiated decades ago being newly discovered and implemented in many venues including such professional education programs as medicine and engineering. But even if members of those professions recognized us as the source, they are not likely to reward our field—at least not until we become more meaningfully established as a profession. To do this, in part, dichotomous thinking must be replaced with positive, collaborative, and cooperative thought. Instead of finding and emphasizing the negatives and differences in positions of others, our leaders must distill the good and positive. They must endeavor to creatively work with those within technology and in other disciplines and determine what of "our" ways and what of "their" ways can be made to work most efficiently and effectively in educational programs. Such important first steps should be undertaken as part of a much larger program to establish a strong identity and to achieve political clout.

A Framework for the Continuum

It may be that our concerns for identity have contributed to the behaviors associated with the dichotomies and that a remedy may lie in our becoming part of a formal and articulated continuum. My belief is underscored from what I have learned from Paul W. DeVore and Peter B. Vaill whose ideas provide a meaningful framework that supports a continuum. DeVore offers a refreshing view of the technologist. It applies to any one of the professional or semiprofessional levels that may be in a continuum and to the programs of the lower schools that interpret and have students simulate technologist behavior. DeVore believes that technology is the manifestation of a high order of insight and creativity that stems from the prepared mind, an educated mind. The prepared mind of the technologist goes beyond discovery of *what is* as is characteristic of many of the other sciences; it uses the intellect to imagine *what can be* and then *creates it.*

The educational role in technology, DeVore believes, is to prepare individuals to function as a technologist and also manifest a set of technologist capabilities that are applicable to minute as well as global situations. Accordingly, the technologist should be capable of: (a) understanding behaviors—meaning that the technologist determines and understands the behavior of technical elements, devices, components, and systems; (b) performing technologist responsibilities with consideration and understanding of the effects of collective human actions or connectedness—that is the notion about the relation between actions and the consequences of those actions; (c) accepting limits or recognizing that natural systems cannot continually absorb the results of inappropriate activities and wastes of humans; and (d) operating within a concept of sustainability which takes one beyond technical systems and devices and who is enabled to assess, design, and redesign systems that are compatible with nature and not exploitive of nature.

Vaill's thesis is that learners must be prepared for the changed environments in which they will live and work. He believes the discipline of learning must be integrated in the learner's being.

Successful learners will: (a) do their own learning, know how they learn, know the faults of their schooling, and identify learning challenges in situations they encounter; (b) be able to decide areas of needed learning and take responsibility to move forward with their learning; (c) be willing to learn things that no one else had to learn before; (d) be willing to learn with others and be willing to learn about an activity in the process of doing; (e) not treat learning as impersonal facts and ideas; and (f) recognize that the principal performance component is the ability to learn.

DeVore's principles and Vaill's view of the learner in the 21st century provide extremely helpful gauges as we move forward to conceptualize the continuum out of which we will prepare a technologically literate person and/or a competent problem solver and/or a knowledgeable designer/technician/technologist/technical manager/engineer/engineering scientist. But the Vaill and DeVore constructs must also include such long-professed values about technology education as: (a) technology learning and experiences can be used to enrich and enable success in mathematics and science studies; (b) it provides a venue for students of particular learning styles or can accommodate all students and all learning styles; and (c) the unique and effective instructional delivery systems we employ go a long way to motivate interest, yield positive learning results, and enable mastery of technical means in the various specialized subjects within the curriculum. (I challenge you to review the section on exemplary practices in this yearbook for further elaboration on this topic.)

We can best achieve what is implied in the preceding framework and the breadth of goals and objectives via an educational continuum in technology—the elements of which have existed but have not been formally articulated. In the United States, for example, the elements of technology studies can be found in many elementary schools, most middle and secondary schools, and many post-secondary schools. These include elementary school technology education; various forms of elementary career education; programs under the rubric of design and technology; science, technology, and society (STS) programs; and mathematics, science, and technology (MST) programs. Under the last three titles, programs exist on lower and collegiate levels. In direct workforce preparation programs, technology programs are found in virtually every vocational high school. Tech Prep is a phrase that has been widely adopted and used for technology and other offerings which have been programmed in the high school to provide interest, motivation, and learning opportunities for individuals whose successful participation will lead them into an articulated community college technology program. Likewise, a program found in many high schools under the title of "Principles of Technology" has gained a foothold and is connected to workforce preparation programs.

The workforce preparation technology programs and the technology-based programs, which are the first two years of bachelor's degree programs, have been part of the stunning growth of postsecondary two-year schools in the US. With regard to workforce preparation, there is also a considerably large system of proprietary schools throughout the nation. Originally designed to offer highly specialized programs, these schools have established a variety of technology-based associate degree programs that have earned the recognition of state accreditation.

There is also an array of university undergraduate and graduate teacher education programs that prepare teachers. There are programs in industrial and engineering and other specialized technologies that prepare individuals for advanced technical professional work in the private sector or government or for careers as college or university faculty. We need also to be aware that there are non-engineering and typically non-technology fields that are delivering technology experiences and content for general and specialized education purposes. Examples can be found in the social sciences, the sciences themselves, and certain business/management programs that inevitably become involved with change, and technology management and various aspects of production, manufacturing, construction, and health.

Finally, the vast training enterprise that exists within business and industry must be considered part of the continuum, as must be the considerably effective training programs of the US Armed Forces. As these are accepted as legitimate for inclusion, the Vaill position on the learner becomes even more meaningful to those who prepare teachers, trainers, and the human resource development personnel who complete the continuum. Within an articulated and formally recognized continuum, individuals can be more meaningfully and effectively prepared as learners for life. They will also enrich their own lives and become more contributing and effective professionals in their own right.

The Prescription

So, what must be done? I suggest that we formalize the continuum. But a basic and very fundamental question remains. Can the leaders of our field change their behaviors for the continuum to be formalized? Are they willing to capitalize and build upon and link the already existing pillars? While I recognize that the International Technology Education Association has recently made some impressive strides in establishing linkages and networks, my tenure in the profession leads me to conclude that our leaders are not yet willing to change their behaviors sufficiently. The profound differences that exist between and among influential teacher educators, supervisors, and classroom teachers are still too strong. Call the continuum what you will but leaders ought to strive mightily to achieve acknowledgment and wide recognition of an interconnected and articulated set of educational experiences from kindergarten through graduate studies that fit the rubric of technology and the principles enunciated by DeVore and Vaill. These dimensions apply to educational programs for general literacy, prevocational, career, and professional preparation aspects of the technology spectrum. Learn from the opportunities missed and do not repeat them. For example, we failed to capitalize on the significant contributions that leaders of our field made to the development of industrial technology professional programs. That initiative could have and should have served to strengthen the new industrial technology programs as well as the teacher education programs out of which they grew. Rather than being mutually supportive, there was contentiousness and competition among our leaders. That ought to be remedied. If we allowed ourselves to think "continuum," the exceptionally strong and visionary contributions that we could make to such developments would be realized and by that happening, the components of the continuum would flourish. Should we succeed in replacing such divisiveness, a strong and highly respected identity can result that will provide the political clout needed to advance the field.

The preceding is an appeal on two fronts. First, I call for reasoned behavior in the treatment of professional differences—that is a matter related to how we operate within our own segment of technology studies. Second, I strongly advocate that we take the lead to build a comprehensive profession in which our segment will find a comfortable and respected home. Forty years of professional experience leads me to believe that taking direct action on these two fronts will determine whether we will succeed in the larger challenges.

Other Paths to be Taken

To these challenges, I offer some additional admonitions and prognostications. They are food for thought as the field enters the new millennium and from them you may take what you wish and leave the rest on the table.

When we refer to "our profession" in the future, we will have an image of a comprehensive technology profession of which the current element we call technology education is an integral part. We will be a respected and valued contributor to the aforementioned educational continuum, and we will enjoy the respect, admiration, and support of members of the other components of the continuum. We also need to assert care in the terminology we use. For example, if we asked teachers in the academic areas we seek to link with what they teach, they are not likely to respond, "science education" or "mathematics education." They will say, "science" or "mathematics." I am confident that if we discipline ourselves to use the term "technology" as our field and encourage practitioners to speak of the specializations that they teach, it will have a positive effect upon our identity and stature. The only folks who teach "technology education" are teacher educators. They prepare people to teach "technology."

Today's leaders must also recognize that a number of the concepts and processes of the past, valuable as they have been, may no longer be appropriate. Even conceptual frameworks that appear timeless and universal are rapidly diminished by the consequences and changes wrought by the very field we profess to teach.

The variety of accreditation processes, such as those administered by NCATE and state departments of education, may explain the conditions that yield school offerings, usually under the heading of technology education, that range from crafts/trades materials and processing emphases to areas represented in the recent conceptualizations. Perhaps what I describe here is a residual of the dichotomy I addressed previously. One would hope that our leaders would adopt diplomacy, professionalism, and strategies that will accept, rather than condemn, prevailing conditions and then would work supportively and deliberately to encourage change.

Unless technology education grows far larger than it currently is, faculty will remain vulnerable unless they themselves learn to develop academic alliances in which their professional skills will be employed. I believe this can be done with effective leadership that translates the notion of the continuum at the higher education level. For example, technology educators may be able to contribute to some, if not all, courses of a number of segments of a continuum, and faculty in those segments can do likewise for technology education. A continuum may also hold remedies for concerns about the inferior quality, direction, and diminished quantity of research in technology education. Among other reasons for the conditions cited is that qualified persons may easily market their generic research skills outside of technology education. An arrangement which brings together researchers of all or most areas of the continuum, to interact, cooperate, communicate, and conceive research programs may yield startling benefits to all research faculty. One example is that such an arrangement may also discourage the researcher to market her or his generic research skills to other areas of education. But more ought to be addressed about research.

Our fledging researchers may not be benefiting from exposure to mentors who are themselves producing quality research. Those who are raising questions of quality and diversity of research and those who ask why there is so little experimental research, ought to first look at the nature, quality, and amount of research products being produced by the senior faculty. Regrettably, I believe there is not as much being produced today as in the past. If the doctoral candidate is not exposed to rigorous interaction experiences throughout all of the graduate program, if research designs and the appropriateness of statistical tests are not adequately challenged, discussed, reviewed, and conceptually tested in interactions with mentors, then the neophyte will have been shortchanged. I fear also that they may leave doctoral programs without a proper attitude toward research and that they will not view research as a lifelong and primary professional activity.

Very closely connected to these research concerns is that few members of our field are disposed to engage in constructive criticism and I believe that comes from our failures at the graduate level. Over the years, each of the journals in our field has published some outrageous stuff. Some has simply been inaccurate in that research designs have been poor, statistical treatments off base, and inferences and conclusions unfounded. In other cases, there have been philosophical/political type comments in journals, which were provocative, simply outrageous. . . and you know. . . both the poor research and the outrageous statements have almost always gone without challenge. These are issues internal to our field. But in addition to the preceding, scholars outside of our field will also find that our less-than-adequate training system in citation checking produces researchers who rely on secondary sources and who often perpetuate errors that have been committed in the literature they cite. This reflects poorly on the individual researcher, on his or her mentors, and upon the profession. It should not be taken lightly.

Earlier in this essay I wrote about Vaill's notions about the learner we need to prepare. His underlying rationale for an educational program is also critically instructive for leaders in another way. He spoke about the learner being prepared to function in an environment that will be as unpredictable as is navigating a wild river. This applies equally to leadership roles and responsibilities. Not only must our leaders be prepared for change, they must possess an attitude that change is a permanent condition, that conceptual frameworks, content, and teaching methods are transitory and ever affected by the dynamics of technology—the very field we seek to interpret. Vaill's approach should be blended with our practice of the stable and enduring ideal behaviors of the scholar. These include flexibility, an ability to consider all sides of a question, a cautious skepticism, a respect for and welcoming ideas of others, a willingness to present and defend one's ideas, a freedom from bias and ideologies, and an expectation and insistence upon excellence in all that they do. By so doing, our field will mature and be prepared to take its place within the greater technology profession in which we will achieve recognition. And that will win for us the stature and identity we seek in schools and society.

Finally, throughout the body of this yearbook, other authors provide examples of and some convincing arguments on exemplary practices and topics for our 21st century agenda. By giving their positions the same serious consideration that you have given to this essay, you will be enriched by an expanded set of possibilities. Collectively, the essays are intended to help you formulate your position and provide the key leadership needed for the 21st century. And then, you must take the initiative to decide the paths the profession will take in the coming millennium. You have no choice. It's your professional obligation.

Unit II

EXEMPLARY PRACTICES FOR THE 21ST CENTURY

Essay 2

Developing A Curriculum Process

Bryan Albrecht
Wisconsin Department of Public Instruction
Madison, Wisconsin

The future survival of technology education as a core discipline in our schools will be dependent on the validity of the curriculum that is delivered in the classroom. We can no longer continue to rely on the transitional relationships between industrial education and technology education nor can we leave the curriculum development process to the suppliers of activities or modules. A high quality curriculum must be one that can be accessed by all students and it must focus on knowledge that is central, challenging, complex and rich in meaning, and valued as a necessary content area for the 21st century.

As we enter the 21st century, many forces will impact the field of technology education. The development of national standards, state and national assessments, and the use of educational technology to deliver content in new and innovative ways are just a few of these forces. Over the last two decades, we have witnessed several examples of how the development of a curriculum has impacted the evolution of technology education. One example is the development of curriculum content organizers—the act of sequencing curriculum and courses around a cluster of related topic areas. Another example is the infusion of a modular technology curriculum. Modular technology tends to compartmentalize the curriculum into short units of activity based instruction. Therefore, the focus of this essay is on the process of developing a quality curriculum that ensures technological literacy for all students well into the 21st century.

At no time in our recent history has the public school curriculum been under so much pressure to change. National forces continue to cause schools to evaluate the quality of their curricular offerings. National standards and assessment, public school choice, and charter schools have all focused on improved student achievement and a higher quality curriculum.

The school curriculum is constantly changing—just as it should be. Some examples of change being introduced into many schools today are global studies, international business, critical thinking and problem solving skills, and electronic access of information through the Internet. Even the traditional curriculum changes as new teaching resources and methodologies are introduced. The curriculum must also be revised to reflect changing perspectives about ethnicity, gender, and other aspects of society.

The manner in which a teacher implements curriculum change impacts students' learning. For example, suppose a school district changes its technology education curriculum to put more of an emphasis on problem solving rather than technical skill development. Teachers who finally implement the new curriculum will give their students more opportunities to learn, demonstrate, and develop problem-solving skills than those who implement it halfheartedly or not at all. As expected, researchers have found that students' opportunities to learn a curriculum determines how much of the curriculum they actually learn.

There is another factor to consider in the curriculum change process and that is the level of concern or need felt by the teacher. Research by Walter Doyl and Gerald Ponder found that teachers follow a "practicality ethic" in deciding how much commitment to make to a curriculum change. This means that teachers judge the curriculum change to be practical to the extent that it is (a) stated clearly and specifically, (b) congruent with the their existing beliefs and practices, and (c) cost-effective in terms of benefits to students relative to expenditure of energy by the teachers.

So how does one go about developing a curriculum process? Recognizing that curriculum plays a big part in establishing the culture of the school, it is imperative that those involved in creating change be aware of all of the factors that influence a person's desire to change. The curriculum change process can be organized into two areas—foundation principles and core processes. Foundation principles provide a basis for the entire improvement effort and establish general guidelines for achieving quality while core processes are methodologies used to base decisions upon related to the change.

There are three basic foundation principles to consider when establishing a curriculum development process: (1) The first principle is developing a focus on student learning. It is broadly defined in terms of complex and comprehensive growth. What will students know and be able to do as a result of learning the curriculum? Any innovation is judged on the basis of its contribution to learning. (2) The second principle involves creating an emphasis on quality. Here, concern is on quality, not quantity, and with the depth of learning, not coverage. Teachers set high expectations of all students and provide the support for students to achieve quality learning. (3) The third principle is constancy of purpose and continuous improvement. Curriculum processes and long term plans are developed and implemented to ensure continuous improvement.

Core processes are the essential tools for achieving high quality learning. Each process is critical in order to establish a clear and effective curriculum development process. Once you have established a curriculum process, you will have built a framework in which people can provide input and react to the development of the product. There are four core processes to consider during this phase: (1) Dynamic shared leadership is the first process as strong leadership is the driving force to instituting any change. A well-informed collaborative team including all the stakeholders works best for long term results. (2) The second core process is data driven decision-making. Conducting a district and/or program needs assessment is critical to building a rationale for continued growth. This process provides the necessary information for creating the change that impacts future planning and budgeting. (3) Cooperation and teamwork is the third core process. Clearly communicating your goals and expectations to the entire faculty will build support and cooperation for your efforts. The content of the curriculum emphasizes the value of cooperative efforts. (4) Systematic professional development is the fourth core process. Continued support for the curriculum change through professional development is necessary, as many of the changes will require new skills by the teachers.

The curriculum development process can be broken down into a series of events or activities. Each event could be described as a stand-alone process. The organization of the event and a careful understanding of the desired outcome as a result of the work to be accomplished are critical to understanding each event. For example, one of the first activities to be conducted should be a district needs assessment to determine the specific tasks that need to be accomplished and their priorities. All too often we jump right into the curriculum writing stage without an identified purpose or direction.

Establishing an effective community advisory council is important also, as the council's members will serve as a link to the community for advice and support for change. Members of the advisory council may be asked to serve on a more specific curriculum planning committee. The curriculum planning committee serves as the chief management group for identifying curriculum needs, developing a curriculum calendar, evaluating the curriculum, and appointing and monitoring the work of curriculum task forces. The committee is usually comprised of school administrators, a curriculum director, department chairs, and classroom teachers.

Curriculum task forces are groups of respected leaders that have knowledge of specific subject areas. Through the power of persuasiveness, they have the ability to influence classroom teachers with regards to curriculum change. Collectively, curriculum task forces may best be described as the K-12 curriculum committee.

And finally, there are instructional planning teams. Teams of individuals evaluate the current curriculum and develop new units of study. The process they follow includes identifying the resources, materials, and assessment tools necessary to teach the new curriculum.

Technology education is a discipline in transition and technology educators must be actively engaged in all aspects of the curriculum development process. Traditionally, technology teachers have responded to curriculum change by revising existing practices and classroom activities. An example would be changing a woodworking class to a materials and processes course but really doing little more than changing the title. Unfortunately, the content is rarely examined and assessed to determine its effectiveness based on today's standards. A highly valued curriculum adds value to the entire educational process. Creating a long term plan that includes the elements of planning, research and development, curriculum evaluation, and revision establishes a pattern of quality and continuous improvement. Technology educators are in a position to establish a foundation for curriculum development as they enter into the 21^{st} century.

Technology will continue to impact the way we live and work. With this change will come the expectation that students will have the opportunity to learn technological skills and be technologically literate upon graduating from high school. How technological knowledge and skills are integrated into the curriculum will depend on the process established within each school district. Technology educators can play a critical role in establishing a quality curriculum process. They will need to establish a strong leadership position to ensure that technology education content is a significant part of the mainstream of public education curriculum.

There are many resources available on the topic of developing a curriculum process and I challenge you to search for additional resources to fully understand the power of a well-designed curriculum. One resource that I have found very useful is a report titled, *Developing A Quality Curriculum* by Allen Glatthorn and published by the Association for Supervision and Curriculum Development. Technology educators must stay abreast of changes occurring in their field in order to incorporate them into their curriculum. As the 21^{st} century agenda for technology education is developed, curriculum development must be high on the list of agenda topics.

Essay 3

Design Problem Solving: The Signature of Technology Education

Allen Bame
Virginia Tech
Blacksburg, Virginia

Robert Booth
University of Wolverhampton
Dudley, England

The 21st century is upon us. As we reflect on the great instructional practices developed during the latter part of the 20th century, one stands at the forefront—design problem solving. Today, it is practiced in several technology education programs in the United States and abroad. We would like to tell you a story about a design problem solving activity and how it solved a problem for one young woman.

As a result of a tragic car accident, Sherry was confined to a wheelchair. Each morning she asked her mother to help her prepare breakfast. If Sherry could only reach the box of cereal on the pantry shelf, she could help herself and her mother, even in this small way. Sherry and her mother needed help and the technology education design team in Sherry's school offered to help them. They asked the team to design and develop a reaching device so that Sherry could obtain her favorite cereal from the shelf.

Once the team identified the specific problem, they researched possible solutions. They learned that a reaching device must include an extender, a gripper, and a handle. They even found that reaching devices were already on the market, but none of them seemed to work for Sherry. So, they set about designing a special device. The easy part was determining the correct length of the shaft of the extender. However, designing a handle that would fit

Sherry's hand and one that she could grip strongly enough was their first real problem. When this design problem was solved, the team moved on to the design of the gripper.

The gripper had to fit cereal boxes of different sizes and shapes, including the round oatmeal boxes. It needed to be sufficiently versatile to grip items other than just one box of cereal. For example, the gripper's surfaces needed to firmly hold cans and bottles. It also needed to be capable of removing smaller items from pantry shelves, such as spice containers.

When the reach extender was completed and tested, the design team applied for a patent before they publicly disclosed their design. Though they knew similar devices were already on the market, their design had several unique features. They asked a local patent attorney to advise them on the patent application process.

The preceding story illustrates what could become the signature activity for technology education programs. Imagine student teams designing solutions to a variety of problems—solutions to problems that help the community, the school, or special people like Sherry. Imagine the good publicity resulting from these activities. More importantly, imagine the quality of learning that takes place as students discover problems needing solutions, work in teams to come up with a solution to a problem, and meet the people being helped by their solutions. Technology education can become known as the school subject where students engage in problem solving, while designing a host of new devices to help improve the school and/or community life.

Designing is a natural part of technological problem solving and is considered an integral element in the study of technology. Designing as a problem solving activity is relatively new to technology education, having become a prominent teaching/learning method only in the past decade. Largely imported from England in the 1980s, design problem solving activities are characterized by the use of design briefs and design portfolios, and the construction of models and prototypes.

The design problem approach to teaching technology education content closely parallels the process that technologists follow when developing solutions to problems. Students involved in design problem solving activities have experiences that prove to be challenging and interesting while emulating the work of modern technologists.

A design problem solving focus in a technology education course has potential for a significant impact on content, classroom organization, teaching/learning methods, and desired learning outcomes. It also has currency across technologies, for example, plastics processing, integrated circuit chips, computer-aided drafting, and automated manufacturing processes.

In courses organized around a design problem solving activity, the problem is first identified and then students work through a variety of learning experiences to develop a solution. The traditional tool and material skills such as drafting, material processing, and graphic communication are learned as needed to solve the problem. Students extend their technological capability through design problem solving activities. Group activities provide opportunities for students to learn the skills and attitudes needed in modern society. Turning ideas into drawings, diagrams, and ultimately, three-dimensional working solutions to a problem create an excitement in learning rarely found in the typical classroom.

Design problem solving has the potential to make a significant impact on technology education. Teachers are using design activities in courses from all the technological systems. In fact, design problem solving might become the signature of technology education courses that distinguishes it from all other courses in a school. It has the potential to garner publicity and recognition for technology education through local, regional, and national competitions such as Odyssey of the Mind, USA First and Duracell Battery contests.

In many schools, the transformation of a materials oriented curriculum was achieved in response to new knowledge and opportunities that became available to teachers and students during the last decade. These opportunities were created by technology education leaders and associations and took the form of new curriculum, including competitions and realistic exercises similar to the reach extender problem.

Infusing design into the technology education curriculum involves the integration of intellectual and practical activities and provides a vehicle for language and number development in students. Outstanding technology education programs have found ways to link design and technology education and yet preserve the strong elements of traditional industrial arts activities; hence, the current emphasis on design and manufacturing in publications.

The corner stones that characterize current design problem solving activities in technology education are found in the unique features of the design process in action. It is important that students have an opportunity to actively participate in order to create new ideas and take increased responsibility for design decision making. Students need to experience the interplay between knowledge, skills, and understanding of how one school subject can augment another. When incorporated into the technology education curriculum, design problem solving provides a line of inquiry, which, once experienced, has wide applicability in adult life—a process linking students to some of the economic, environmental, and social aspects of life.

Traditionally, technology education in schools has been dominated by teacher developed tasks and teacher oriented learning where value is placed on the development of a repertoire of hand skills, detailed knowledge of materials, processes, and equipment, and selected aspects of manufacturing. Student work resulting from this approach is often criticized because it falls far short of the desired quality.

The shift towards pupil oriented tasks that incorporate knowledge and skills from several disciplines, notably math and science, often focuses on problem solving associated with the design process. The result can be a severe reduction in the traditional focus on materials and processes and fewer manufacturing activities, but with a sharp increase in design activities. But unrestrained focus on designing activities, with insufficient material and financial support, may result in programs that fall short of the innovative, exciting, and imaginative work that often comes from the more traditional industrial arts programs.

Teachers and students should be innovative and entrepreneurial; their thinking enlivened by the full extent of resources available but also restrained by commercial realities. Personal horizons must be broadened within the limits of practicality and good design practices. To provide opportunities for pupils to innovate in the classroom, teachers must first gain these experiences themselves. Once they experience them, design problem solving will become the signature of technology education.

Essay 4

Primary Design and Technology—10 Years On

Clare Benson
University of Central England in Birmingham
Birmingham, England

An opportunity to contribute to the introduction and development of a new curricular subject arose for those in primary education in England and Wales in 1990. This was an opportunity that had not presented itself since before the 1944 Education Act. This was an exciting and challenging task—a once in a lifetime opportunity. Whilst there was growing evidence of a movement to include the subject into the primary curriculum worldwide, England and Wales were the first countries to introduce it to children aged 5-11 years as a mandatory requirement. Surely educators and those in government would celebrate this achievement; strategies to support the implementation of the subject would be in place; and teachers would accept the challenge, realising that they were making history. Or was this the case?

Before 1989 and the introduction of the National Curriculum, primary schools in England and Wales drew up their own curricula and schemes of work, and much was dependent on the enthusiasms and strengths of heads and teachers in individual schools. Support grew for the introduction of design and technology into primary schools, and Lady Parkes led a commission to review the inclusion of the subject both at primary and secondary levels. In 1989, the National Curriculum was introduced and subjects were phased in. After the core (English, mathematics, and science) was introduced in 1989, design and technology became a statutory requirement for all 5 and 7 year olds in 1990. Over the next three years, the subject was included in the curriculum of the remaining year groups and in 1996, the first cohort of children left primary school having experienced design and technology in every year of their schooling.

To ensure the success of this new innovation in primary schools, it would seem obvious that careful preparations should have been made. For example, certainly issues relating to schemes of work and staff development should have been addressed and printed resources should have been developed. However, in reality very little was achieved before September 1, 1990. Documentation reached the schools in the previous summer term, but as teachers were still working to ensure that the core subjects were being planned and taught appropriately, there was little time to study new documentation until September and there were few opportunities to run teacher in-service courses. Moreover, the initial document proved difficult to access for classroom teachers, who had little knowledge and understanding of the subject, as the language was too technical and the content was too detailed.

Over the following 10 years, many issues have been addressed, whilst others are still areas for concern and, if the initial successes are to be sustained well into the 21st century, it is these that must receive focus. First, the documentation needs to be reviewed both in terms of the amount of content that has been identified and the way in which it has been written. Over the 10 years there has been a number of reviews in order to achieve a more manageable and intelligible document. The most significant change was in 1995 following the Dearing report. The whole primary curriculum was reviewed and design and technology pruned to produce a realistic curriculum and a clear structure for its delivery. The majority of teachers easily understood even the text of the document. However, the changes made in 1998 have resulted in a document which maintains the philosophy and includes the main areas of content but which provides very little detail. The lesson has not been learnt that fewer words do not necessarily mean a simpler document and one that is easily understood. It should be made clear that as the reviews took place, Wales developed its own documentation and now stands apart from England. Thus, as we enter the new millennium, we have skeleton programmes of study which give a flavour of the subject; but for those who have little understanding of design and technology, it will be essential for them to refer back to previous documentation.

However, for teachers who may be more concerned with translating the programmes of study into schemes of work, much has been achieved. Until 1998, there was no national scheme of work to indicate how the programmes of study could be translated into classroom practice. Whilst schools would not have wanted a rigidly imposed scheme, it would have been very useful to have an example of a scheme which offered breadth and balance. It has proved very time consuming for each school to develop its own, despite the support offered from Local Authority advisors and from the Design and Technology Association (DATA). It was not until 1998 that a national exemplar scheme of work was produced. Schools could then choose to adopt it, make modifications to ensure that it fitted their particular needs, or use it as a standard against which to judge their own scheme of work. It has proved valuable and it seems certain that had this been available in 1990, implementation of design and technology in schools would have been considerably quicker.

The lack of teachers' knowledge and understanding, and thus their lack of confidence to teach the subject, has always proved to be an issue that needed to be addressed. Different strategies have been used to tackle this issue over the past 10 years, but it is still one which remains a concern. Early on, advisory teachers were appointed to run in-service courses and to work alongside teachers in the classroom. Research has shown that this latter strategy is very successful in bringing about positive change. Funding was given to run long courses of 10 or 20 days. The provision of finances for supply cover meant that teachers could attend during the day had many advantages: (a) teachers were not tired as on many twilight courses; (b) they were able to build-up self support groups within the courses which continued after the courses finished; (c) the courses were long enough for participants to gain the knowledge and skills they required to effectively teach design and technology in their schools and to support other staff members; (d) and many of the courses had a post graduate qualification attached to them, which was a relatively new development. Inspection reports have shown that whilst the problem of insecure knowledge and understanding has not disappeared, it is being addressed. However, this is certainly an issue which needs to be focused on in the coming years, especially as recent changes to funding may mean that these courses are cut or certainly limited. It is difficult to accept why evidence of success is not heeded.

The initial lack of in-service opportunities might not have been so detrimental had there been appropriate printed materials available which teachers could use to support their teaching in the classroom. However, publishers were quick to respond to this need, as indeed was DATA. Materials were developed which have supported the development of knowledge and understanding, practical skills, classroom management and organisation, and which have offered a variety of ideas to aid the planning of appropriate, exciting classroom activities. With the Government's present focus on literacy and numeracy, future materials will need to include strategies to show how these two core areas, together with science, art, and information technology, can be linked with design and technology in a meaningful way as teachers will need to combine study areas if they are to cover all the content in the National Curriculum.

Whilst the implementation of design and technology has taken place across the whole primary age phase, it has been interesting to discover that more success has been achieved in early years (children aged 4-years) than at Key stage 2 (children aged 7-11 years). Trends show that both teaching and learning are not as good within the age band 7-11 years and anecdotal evidence would support this. There has been little time for research to focus on reasons for this, but relating the inspection findings to needs would suggest certain factors. Generally, teaching and learning are shown to be of a higher standard in early years. Maybe this is because of the way in which early years' teachers work across the curriculum, using a variety of teaching and learning strategies; less knowledge and understanding is required to deliver a successful design and technology session and therefore teachers are not so daunted by the subject; and early years' teachers are more use to applying the more varied classroom organizations which are needed in design and technology.

Over the 10 years, 1990-1999, monitoring and evaluation of the implementation of design and technology have taken place, mainly through Her Majesty's Inspectors Reports (HMI) and through a national survey each year by DATA. Both reports are published annually and have provided much valuable data to enable us to gain an overview of the state of the nation. Some schools immediately saw the benefits of design and technology for their children and this was sufficient motivation for teachers to ensure that the subject quickly became part of the school's curriculum. Some schools had enthusiastic coordinators who motivated those with less enthusiasm. Yet, other schools put the documentation to one side for a variety of reasons and the introduction of the subject was left to chance. Whilst there are many critics of the methods of inspection in England, national inspection of schools does highlight those schools which are not giving their children their entitlement to a design and technology curriculum. Indeed, some teachers welcome the fact that design and technology is highlighted as a concern during an inspection as it should lead to appropriate funding and a whole school approach being introduced to ensure that standards are raised.

Whilst the needs of teachers have been, and are still being, addressed, the successful implementation of the subject will always be partly dependent on the enthusiasm of the teachers and children. It has to be seen as a valuable experience and one that will have benefits throughout the schooling of a child and into the world of work. National inspection reports have identified that almost all children enjoy the subject and it is a subject that motivates and is relevant throughout life. Providers of 10 or 20 day design and technology courses are all able to provide case studies of large numbers of teachers who start the course lacking confidence, and with a cynical attitude, but who leave the course motivated, enthusiastic, and wanting to initiate activities in their schools as they are so convinced of the subject's worth.

From an inauspicious start, it is hard to imagine that design and technology would have become firmly embedded in the primary curriculum and that best practice in England is best practice worldwide. We have now reached a crossroads—10 years on. In the year

1999, a new primary curriculum, including that for design and technology, is being created. There has been continuing evolution over the previous 10 years and much has been learnt. Change for the sake of it would seem a retrograde step when so much progress has been made. As we move through the new millennium, we need to build on the past 10 years. We now have a workable document which, more importantly, is one which is appropriate, relevant, and will lead to and support quality design and technology in the classroom. Teachers have become more confident in the delivery of the subject but this concern still needs to be addressed through in-service. Whilst teaching is improving, planning still needs to be more focused, providing a series of structured and progressive activities, that can be delivered in the primary classroom. Children are now building on knowledge and skills as they progress through the primary school. And, there are many appropriate resources to support the delivery of the subject in the classroom. As the new curriculum emerges for the year 2000, we stand at a crossroads. It is imperative that we do not turn left or right or make a complete reverse turn, but continue on down the road—a road that has led to the successes of the last 10 years.

Essay 5

Why Can't the Sun Shine Everywhere at the Same Time?

Robert Booth
University of Wolverhampton
Dudley, England

Allen Bame
Virginia Tech
Blacksburg, Virginia

"I can't imagine many things in my life to better an international experience. It has provided me with some excellent ideas and a thirst for more; it has enhanced my personal and professional development to a point where I can only improve." These are the words of one participant returning from an international technology education collaboration program.

While there are several successful yet isolated pockets of international collaboration, including classroom related subject development, to visit classrooms overseas is a rare opportunity for many technology educators. Exchanging documents on national and local administrative systems, sharing philosophies, and comparing physical facilities typify much of the dialogue that has transpired to date.

Establishing and then maintaining international contacts have not always been easy because the sun doesn't shine everywhere at the same time. However, the only barrier to setting up an intensive talk and vision line to sample overseas contexts is the 24 hour time zones. As the computer web universe begins to abolish distance, the need and cost of traveling have brought into focus the barriers that so often operate against visiting personnel.

It takes a mere seven hours to cross the Atlantic Ocean to pioneer an exchange of colleagues, teaching programs, cultures, and values. As the aircraft climbs smoothly through the cloud cover and sunlight pours into the cabin, the noises of the engines diminish. The airplane quickly catches the darkness and tilts to change course. The miracle is how the aircraft feels its way across thousands of miles of blue and then black water, to a foreign haven of light. At 35,000 feet, it is possible to see the telltale signs of human technological endeavors in the spume from a ship and the agricultural boundaries separating one farming technique from another. Appearing at the end of the journey is a grotto of orange lights thrown down on a black velvet pillow; shimmering strands transform themselves into streets, houses, and vehicles, and the noises from the engines change to produce a sinking sensation and the descent to a foreign land begins.

International collaboration in industry is essential to national business and economic success. As traditional boundaries of sovereign nation states are eroded by a global market place, it is sensible to explore alternative ideas on international technology education and the economic and cultural variables shaping them. Projecting technology education as an internationally creative, innovative, and unique curriculum area is not a bad start. Presumably, it is vitally important in the next generation of technology education that its interdisciplinary edge remains as a tension between those dispensing knowledge and those receiving it. To perpetuate this tension, teachers of technology education will continue to cultivate the potential to inspire creative thought and develop the ability to resist paralyzing it. Behind the facade of educational politics there is substance in a modernizing theme for international technology education, but teachers need time to manage periods of change; they need opportunities to reflect upon their current practices and develop new ways to approach teaching technology education. Regular training is not easily attainable but self-help and in-service are easy. So, what bolder way is there to establish new horizons than linking with international partners? After all, friendship is both professionally and medically sound.

Some school subjects have notable success in international collaboration. People involved in the development of technology education pedagogy and content have generally not benefited from international contact nor have they tried necessarily to establish contact. For the few people who have benefited, there have been cultural appreciation, co-operation, and personal development well beyond their initial objectives. Technology educators now have opportunities to establish routes to an exchange of pure subject information; this is the single most important objective for a successful and lasting global contact.

The web universe speeds up what can be achieved over time. The first global links are so easy to sustain by progressing quickly beyond the traditional pen pals approach to a co-operative development on a specific technology education issue. Comparing the results of joint activities with teams linked by computers in classrooms and laboratories is an excellent preparation for an international visit. Although the Internet has perfected the 24-hour day, the co-incidental hours of daylight limit instant communication. A 6-hour time difference between colleagues results in six office hours working together—the greater the time difference the less coincidental hours exist. If the sun shone everywhere at the same time, far more coincidental hours would be available but an international visit seems to be a more realistic and worthy alternative to pursue.

We have to learn that international contact means a fundamental policy shift for many technology educators. At the same time, instant global messaging and picture technologies undermine the very cultural and social values teachers hold dear because technological development moves faster than educational development. Computers are so small they are disappearing into the fabric of life which means that 21st century international technology education is for students and teachers who are surrounded by the most inanimate objects that think.

At times, all teachers feel professionally isolated—isolated from stimuli and isolated when they don't have any good ideas. Sometimes they seek justification for their ideas. Isolation is overcome through informal conversation as well as exchanges of good practice. It is enlightening to view and be viewed; what is taken for granted takes on new meaning and there is a chance to endorse and challenge technology education practices and to celebrate excellent student work. Personal progress is made by sharing rather than blind adoption of other nations' technology education practices. An analysis of a radically different system leads us to draw out how well it works and why. The future can be glimpsed by examining the impact of a technology education initiative advanced by one nation while avoiding the errors of others. There are rich pickings in international similarities and differences created by policy, subject initiatives, resource support and tradition, rising expectations, and understanding of subject entitlement.

Technology education teachers can take advantage of communication technology to build international school links. Links give students opportunities to equip themselves with social skills and attitudes essential for a comfortable fit into work and adult society as well as equipping them with subject knowledge. There is an abundance of international exchange schemes that tend to rise rapidly and then fall, as the initial funding enthusiasm becomes more difficult to generate. In Europe, for example, schemes have existed since the early 1950s with the rise of twin towns and cities—a scheme that continues today. Similarly, in the United States, affiliations blossomed after the People to People program proposal at the 1956 White House Conference included several initiatives such as the Sister School exchanges and School Partnership International.

Out of frequent communication and the sharing of teaching resources, the idea for the exchanges of personnel arises. International travelers find it easy to pass on their experiences so others can take advantage of the professional fulfillment that comes from international exchanges. As we begin to resolve the problems confronting technology education, international co-operation and understanding takes on a new imperative. The question of whether the web universe is a substitute for international travel brings into focus that which is important to experience overseas because it cannot be sensed in other ways. It is the noise, smell, beauty, temperature, climate, and elements of national culture such as national identity, age, courteousness, tradition, and the time of day that can only be sampled by visiting and experiencing firsthand.

Before attempting a leap into the international unknown, time must be invested in preparing, planning, and exchanging information—only then will the experience be successful and lasting. For those enthusiastic teachers who want to improve upon what they are doing already, there is an opportunity to build an international network of technology educators. Opportunities also exist to build a network of change agents who experience the excitement of growing as professionals and who value the inner satisfaction of knowing that their work is noticed by others. Tapping into the potential of an international technology education network for the first time is as simple as exploring the web pages of national subject associations. From this easy beginning, it is a simple next step to make electronic contact with teachers in the classroom and curriculum support groups; sharing the responsibility of contributing to subject development through joint student activities that can be compared and exhibited. Then, the ultimate step is visiting a classroom in a foreign land.

The sun begins to rise on landing seven hours adrift of body clocks and 4,000 miles from home. Arrival at an airport is tinged with aviation fuel and the endless corridors appearing as extensions of aircraft cabins. Clothes are inappropriate, either too much or not enough, to cope with the ambient temperatures. Driving away from the airport along a busy highway, exit signs flick past with names on them that seem familiar, into a crowded thoroughfare lined with shops and houses, and on to the suburbs of quieter roads and fewer people. Arriving in another country, made familiar through correspondence, is akin to entering a time warp, a land untouched by the familiarities of home but with visual clues that are the legacy of a thorough preparation. The first morning, jet-lagged and woozy from sleep, meeting new colleagues, and a myriad of new stimuli, the new experience begins.

"I was so excited about the visit I made, there was nothing to match the experience of a lifetime which I shared with my family, friends and colleagues. Travelling overseas has taken the fear out of me and cultural activities have influenced my life; I realize I'm an emerging leader in my field and I want to influence and encourage others. I also realize communications technology for teachers is an instant as time zones will allow and jet-lag is a penalty for longitudinal travel. Why, therefore, can't the sun shine everywhere at the same time?" These are the words of another participant returning from an international technology education collaboration program.

Essay 6

Hands-on, Minds-on Learning: Putting It All Together

Barry N. Burke
Montgomery County Public Schools
Rockville, Maryland

Just last week their technology education teacher had told them. They knew they had an unfair advantage. Soon the top place prize would be announced and they would be named the recipients. Excitement throughout the auditorium was mounting as the bronze and silver winners were announced for the "One Thing Leads to Another" challenge. And then, "First place, $5000 and the gold medal goes to . . ." When their school was announced as the gold medal winner, the entire auditorium broke out in cheers, screams, and applause. Thousands of students from around the state were competing, yet they knew they had the advantage—of this they were sure.

In the beginning, it was the prize money that intrigued them. But once they began thinking through their solution, they became obsessed with learning all they could about the mechanical technologies involved in their design. But there was more than that. For the first time, they had become involved with marketing firms, web-page development, multimedia productions, oral presentations, documentation, and technical report writing. As they walked up to the podium to receive their award and medals, each of the team members was thinking about how rarely they had worked this hard and yet, had so much fun learning.

Back at school the next day, students that won the gold medal met to reflect on their experiences at the competition. They were excited and said things like, "We really had the upper hand," and "They didn't have a clue." The teacher facilitated a discussion with the students about what worked and what didn't. The discussion included a close look at the competition to analyze how the students had met the challenge and to identify ideas that might have been incorporated to improve their own technological contraption. Just before they left for their next class, the gold medal students said to the teacher, "You were right—we had the advantage. Thanks for your help." To which the teacher replied: "Be sure to tell that to your English, science, and math teachers, because they're part of the team too."

At the schools where the teams did not win gold, silver, or bronze medals, students came to class, barely spoke about the competition, and didn't even reflect on what had happened other than saying, "We lost—what's next?" The teachers did not engage the students in any reflection or analysis. The teachers simply moved on to the next unit of study.

It was a good lesson for the students in the school that won the gold medal. Students took with them a host of skills—skills that were broader than just the skills learned in their technological studies class. Their teacher had called it applied learning, but all that the students really knew was that all the things they were doing and learning were related. Students were involved in an integrated approach to learning. As a result of students enrolling in the Exploring Technological Concepts and Matter & Energy courses in the ninth grade, the concepts and applications now made more sense. Some students in the Pre-engineering course simultaneously enrolled in the Physics course while others enrolled in the Chemistry course.

Technology education presents a unique opportunity for schools where the school environment is viewed as a place where students can experience learning rather than reading about it. The traditional integration model of teachers collaborating on individual units, maybe only one or two a year, is superficial integration at best. In schools where the teachers are able to present and organize a unified approach to learning, the results in terms of student success can be staggering.

Applied learning can occur in isolation—whether it is in technological studies, science, English, or social studies classes. To teachers and students, the real power is in creating an integrated approach school wide. In reality, this is perhaps easier to do in elementary and middle schools. At the elementary school level, teachers are able to weave the concepts and hands-on activities into the everday curriculum. At the middle school level, students often work in academic teams. Interdisciplinary activities are ongoing in this configuration and draw upon the teachers' expertise in their content areas to make curricular connecting activities. Organizationally, teams in the middle school are composed of English, science, mathematics, and social studies teachers. Technology education teachers are rarely included on these academic teams, and are attached to a team of teachers called the "Arts" team. The result is that technology teachers are contracted to have the students build this or that with no real connection to what is being taught in the other subjects.

Traditionally, little coordination occurs between disciplines at the high school level. In situations where the technology and science (or mathematics, English, or social studies) supervisors meet to align curriculum and organize training opportunities, collaborative teaching is more likely to occur. Collaborative teaching is different than team teaching. It is not a one-unit project and it is not one content area using the other to build things. It is a collaborative responsibility to provide students the opportunity to develop the ability to see and apply the concepts that they are learning—*Hands-on, Minds-on learning.*

Hands-on, Minds-on learning can occur at all levels—elementary, middle, and high school. It begins, as previously suggested, with supervisors who are willing to look at their curricula and cross match goals and outcomes. Often, it requires the reordering of instructional units to accommodate the collaborative nature of the programs. Training opportunities are then discussed to support the programmatic changes. It is not unusual to have teachers who are uncomfortable providing instruction in another content area. To successfully implement such a program, teachers from each content area attend training sessions that support the collaborative effort.

The curriculum that is used in the classroom must reflect hands-on, minds-on integrated content. Activities must be based on a set of instructional units that cover instructional content that are consistent with state outcomes and national standards. It is not uncommon to find teachers who are hesitant to teach concepts outside of their area of expertise and if allowed, they will revert to only the topics they know best.

To implement hands-on, minds-on instruction, teachers must be able to allow students to go beyond the four walls of the school and explore areas that are unfamiliar to them. Activities are developed that allow for teachers who have no expertise and those who have extensive expertise. Teams of technology, mathematics, science, English, and social studies teachers develop the activities to insure that the academic concepts are a seamless part of the challenge.

Consider a situation where all students in a grade level are expected to take two courses simultaneously—one technology education and one science. Teachers meet and prepare lessons throughout the year to insure that the concepts and applications are being covered. In science, for example, students may explore the concepts of simple and complex machines. They may also have demonstrations and laboratory activities to create a better understanding of the concepts. When these same students attend their technology education class, they are involved in full-scale applications of simple and complex machines as well as a technology challenge problem that frames the use of these machines in a real world context. The solutions generated by students are guided and facilitated by both the technology education and science teachers.

As the profession continues to evolve and the standards for technology education become accepted and institutionalized, teaching strategies and the development of content will continue to be refined and implemented. The basic concept of hands-on, minds-on learning is one that will remain constant in the profession. Professionals should not be lured back to the study of industry because it is comfortable for them. The public's perception is that we are *hands-on* and unfortunately, in many instances the public still believes that we are bookend builders. Bookend builders require very few *minds-on* skills. It is critical for technology education and technology educators that a theoretical, practical, and applied balance be maintained. No longer can technology teachers exist as an island in their schools. Technology education or technological studies and technology educators must be part of the whole school solution.

Questions remain, however, that need thoughtful and insightful answers. I recommend that you give serious consideration to the questions that follow. Unfair advantage or quality education? Good teachers play to the strengths of their students. Did the teachers help these students grow, help them see and reflect, and help them experience places and opportunities that will prepare them for a world of change? Is an integrated approach to applied learning the minimum skill set that teachers should strive to attain? Can students see the difference between good instruction that prepares them for the future and instruction that is for leisure time activities? It is clear that the parents of the gold medal winners (with the unfair advantage) would view technology education in a positive frame of preparing their children for the future. Should marketing be a key component to validate and change the public's perception of technology educators from bookend builders to teaching about technology?

Traditionally, public education has delivered instruction in neat, well-defined parcels. As the national standards take hold and technology education emerges as a major player in schools nationwide, it is crucial that the way instruction is being delivered be revisited. Access to global resources is at our students' fingertips. When they experience activities that span multiple subject areas, they learn because it makes sense. Technology education is a natural integrator because the study of technology spans all content areas. Teachers are the key component in the delivery of quality instruction. Can teachers motivate students? Can teachers guide students to be critical thinkers? Can teachers help students to make curricular connections? Can teachers help students to better understand the importance of being lifelong learners in a changing technological society? I believe the answer to each question is a resounding YES and that *Hands-on, Minds-on learning* is the vehicle for *Putting It All Together.*

Essay 7

Imagineering: Creating the Future

Barry N. Burke
Montgomery County Public Schools
Rockville, Maryland

The audience stood and applauded as the three students walked across the stage. Independently, the students thought back on the journey that had brought them to this moment in time. They considered their hard work and countless hours of frustration that had led to their unprecedented success. Their technological studies teacher had introduced the concept of *imagineering* almost three years ago. She had coined the term and defined it as *creating the future.* As they had waited for their new assignment, the students had chuckled at the mere thought of creating the future.

They did not know each other then—three of the most diverse students in the class. In fact, when they had been put in the same group, each of them thought this was going to be a real nightmare. Each had gone home to complain about the group's composition. Their parents had explained that there was power in diversity and that it is important to be able to work with people who are not the same gender and ethnicity as themselves. As it turned out, they became best of friends because of this technological studies project. All three were now confident that they had a future beyond high school.

And so it happened. This team of unlikely students had collaborated to design and construct a system that could measure temperatures in an automobile and maintain constant independent comfort levels for each passenger. At first, just finding a problem had been difficult—but their teacher had guided them into thinking about problems they had encountered as part of their everyday life. Their problem solving journey had taken them out of their small hometown to major automobile manufacturers, to the United States Patent and Trademark Office, to HVAC companies, to many other small businesses, and to the Internet. Each segment of the journey had helped them develop their invention. Now, as they walked across the stage to receive the Imagineering Award of Excellence from the Chamber of Commerce and the High Technology Council and its member companies, they were a proud team. The students now held 13 patents for their work; contracts with automobile and airline manufacturers for their solution; offers from a variety of firms who wanted them to be members of their research and development teams; and an education that had prepared them for a world of technological change.

Technology education or technological studies holds the promise for the development of sharp and creative human minds. As the profession has moved away from the traditional industrial project approach and focused its curricula on the study of technology, the strategies used to help students learn and to be successful have changed significantly. While teachers once used tools to teach concepts related to product construction, teachers now use strategies to help students build upon prior knowledge to solve open-ended problems.

The ability of students to imagine solutions to broad-based problems has had a profound impact on the classroom environment. Teachers use the imagineering strategy today to help students look beyond a set of parameters or constraints, for example, to develop or re-engineer the way a product or device is designed. Imagineering has four implementation stages. These stages are parallel to the design process and its four components—input, process, output, and feedback.

In stage one, teachers begin the imagineering process by challenging students to imagine all possible solutions to a given problem. The exercise is often a think-pair-share or jigsaw where students consider what it is they already know about the problem. As you can imagine, problem identification is a critical piece in the process. A problem must challenge students to draw upon their creative and critical thinking skills in the development of possible solutions. First, the problem is framed by the teacher and then developed by the students. In the case of the three students who designed and constructed a system to measure temperatures in automobiles, they may have been studying thermal technologies. The teacher framed the problem so that the students were challenged to look at a variety of technological systems such as automobiles, household appliances, or communications devices. From this point, the students began to explore what they already knew about these systems and identified problems that technology could help resolve or improve. The group chose a system, described the problem, and brainstormed possible solutions. At this point, the students began to reflect on what they knew and what they needed to know to arrive at a successful solution. The power of the group helped to expand what was collectively known and what they needed to learn in order to develop the design.

In stage two or the engineering stage, the imagineering process involves the critical analysis of the components of the solution. The method the teacher selects to introduce the lesson determines how students proceed at this step. In some situations, the teacher might use an existing technology solution and ask how this might be recreated more efficiently. In a more advanced level of proficiency, students create the solution from the beginning by combining core technologies to create a system that meets the constraints of the problem, and is determined by the group to be the best solution.

Stage three involves the conversion of ideas into working models or prototypes. Technology education programs have traditionally been strong in this area, although in many instances programs have emphasized construction skills over critical and creative thinking skills. In imagineering, students learn to use a broad range of tools and equipment based on the type of problem solution they have conceived. It is important to note that not all prototypes must be working models. In fact, part of the power of the imagineering process is to create mock-ups that stimulate higher level thinking about how the solution might be constructed. For example, students in the sixth grade may imagineer a solution to a problem. However, depending on the complexity of the solution, they may only have the manipulative and tool skills to create a model, not a working prototype.

Stage four is the reflection stage of imagineering. Reflection is essential to the development of critical thinking skills in students even though many teachers are prone to downplay its importance. At this stage, students are encouraged to reflect on the process that they used to create the solution as they present their findings and prototype to the class. Every stage should be assessed in a manner that helps students to see that the process (technological or problem solving) is critical to the development of an acceptable solution. An integral part of the reflection stage is to examine ways the group might modify their thinking if they were to start the process over from the beginning, including what would they change and why.

Imagineering as a teaching strategy is critical to the future of the technology education profession. It provides students the opportunity to be creative and imagine what is possible by taking their ideas from the imagination stage through the development, construction, and reflection stages. In practice, it is a guide to teachers that helps to develop critical and creative thinking skills in students. Overall, teachers that use the strategy find there are far fewer problems with student behavior, student enrollments tend to increase on an annual basis, and students that complete their classes do so with problem solving skills that will help them in every field of endeavor. In addition, each year teachers improve their skills as facilitators of learning, simply by continuing to encourage students to ask more quality questions about the work they are doing.

Teachers who use imagineering as a classroom strategy are positively impacting the profession at all levels. As we know, pre-service and in-service training opportunities are essential to the success and future of the profession. Teachers who are prepared to help students be critical and creative thinkers are in short supply. Teachers refine their skills when they are modeled during training and used as a daily part of instruction, both at the pre-service level and within the school system's in-service program. At the teacher preparation level, prospective teachers that learn how to organize and maintain high performance groups are the most successful using the imagineering strategy. Teachers that are unable to effectively manage diverse groups in the classroom are at a distinct disadvantage.

At the in-service level, teachers are empowered to develop an imagineering style that works best for them in the classroom. Drive-by trainings are typical of public school systems and should be reconfigured to include a wide variety of training opportunities, action research, peer coaching/mentoring, and teacher support. Experienced as well as new teachers can benefit by this type of staff development. (Note: Drive-by training is a one-day offering of instruction without follow-up and does not follow a common theme based on the needs of the participants.)

In addition to the preparation and training of teachers, school systems and teachers must continue to develop a curriculum that reflects the study of technology and the national standards. Opportunities for schools to study technology and to make technology a major organizer (core subject) in the school environment are inherent in the standards. A solid curriculum is essential to the development of activities that support the imagineering concept.

Imagineering is a simple term that often sparks the ingenuity and creativity of students and teachers. The three students who crossed the stage were reflecting on the innovative characteristics of their teacher and how imagineering helped them to be the best that they could be. When using the imagineering strategy, the teacher was able to help these students see beyond the school house walls to create their own future. Successful teaching in itself is an imagineering process. Professors help to develop the strategy, colleagues help to refine it, and school systems help to support its implementation through the technology curriculum.

As we enter the 21st century, questions remain. What is the state of the profession? How many teachers are actually teaching technology? Are teachers still preparing students to enter yesterday's workforce? How many school systems still have not aligned their curricula with the national standards? How many teachers skip over the critical stages of problem solving because they just don't know how to do it? In the final analysis, it remains clear that all teachers must possess a broad range of teaching strategies that helps students develop solutions to create the future. Imagineering is one of the strategies.

Essay 8

Technology Modeling

Robert A. Daiber
Triad High School
St. Jacob, Illinois

Technology modeling is a pervasive instructional approach for teaching technology education. This exemplary practice highlights technology education as minds-on/hands-on learning. As education progresses for the 21st century, technology modeling portrays a stand out for classroom instruction to accomplish the learning outcomes for a new era of education.

Colleagues from other fields of study have turned to watch technology teachers utilize this instructional practice to motivate students and increase learning in their technology laboratories. Science and math teachers too have begun to employ technology modeling in their classrooms because of the power this exemplary practice has in the learning environment. Why is technology modeling a dynamic instructional practice?

To explain how technology works in our world, technology modeling is an instructional practice that helps meet the needs of visual, tactile, auditory, and kinesthetic learners. Students from all modalities of learning have positive experiences in designing, planning, and building technology models. Visual learners gain the experience of seeing the pieces of the model fit together to become an operable technology system. Tactile learners touch and place the components in the proper location, which enhances their comprehension level. Likewise, auditory learners hear about how the model should be built and operated which aids in their knowledge development. Kinesthetic learners are active students and find technology modeling an exciting school experience because they can move around as they learn. As you can see, the uniqueness of this exemplary practice is that it is flexible in its instructional design. This flexibility allows it to be used with various learners and classroom settings.

Technology modeling offers teachers an instructional means to bring simple and complex forms of technology into the classroom. For example, students may design and construct models of early tools made from sticks and stones as a history of technology activity. These replicas provide a hands-on understanding of how technology was designed and built in a prior era. Likewise, technology models of complex systems such as a model of a nuclear power plant or slab casting system at a steel company demonstrate the tremendous thinking skills for planning and building a sophisticated system model.

The use of technology modeling works well as an instructional approach to teach problem-solving skills. Students may be presented with a problem situation and then be asked to construct a model to represent the solution. Historically, technology teachers have utilized this instructional practice in a popular activity of bridge building. In this activity, students are commonly assigned to build a model bridge over a given span. Students select various types of bridge designs to accomplish the task. Whether the bridge design is arch, cantilevered, truss, girder, draw, cable-stayed, or suspension, the students are involved in careful planning, extensive design work, and detailed construction to complete the bridge model. The test of the bridge is just as educational as the design and construction phases. The assessment of the model entails application of a load to the bridge while it stretches a span. Students observe firsthand the forces that may cause bending, shear, compression, stretching, or twisting of the bridge structure. It would not be as dynamic of educational experience to learn these concepts through observation without a bridge model.

Another excellent learning experience that comes about as a result of technology modeling is an engineering design experience to build an aerodynamic vehicle. The design and building of the vehicle provide students with a working knowledge of the qualities of aerodynamics. As students mold frames to represent their models, seeing the objects from a three-dimensional perspective develops realization. No other instructional approach can foster such tangible learning outcomes.

Technology modeling has a direct influence on technological systems approach to instruction. An examination of the input-process-output-feedback framework for instruction leads one to realize that factual content alone is not enough for the technology classroom. By applying the factual content to build a technology model of a technological system (e.g., computer network, assembly line, or satellite communication), a more concrete learning experience is provided. The technology model becomes the focus of the systems approach to instruction.

Using technology modeling can also enhance integrated learning units. Math and science instruction is often criticized because it seems removed from the real world. By integrating math and science principles into technology models, practical applications of math and science may seem more real to students. Each year students across the United States build technology models better known as Rube Goldberg devices. These models exemplify application of science and mathematics through an engineering design. These models utilize the motion of an object such as a small ball or marble which trips a lever and causes other motion components to move which in the end produces a planned result (e.g., traps an object, breaks an egg, or sharpens a pencil). Such technology models provide the visualization as to how technology works. The challenge presented to the students is the building, testing, trouble shooting, and managing the system. In conjunction with the National Science Teachers Association, the Duracell Corporation sponsors a scholarship competition each year. Students in grades 6–12 are challenged to invent battery-powered devices. These devices are models of new technology. It is the building of the models that brings about innovation for science and technology students. It is one step to have a great idea, and another step to build a device and see it operate.

Social studies teachers may consider having students build models of war ships, fighter planes, cotton gins, or other pieces of technology that greatly impacted our history. A student's interest and involvement in class is often raised by becoming actively involved in doing a technology model. The activity is easily integrated with a technology class in which the two instructors agree on the required tasks for the history of technology model.

Technology teachers who introduce future studies as part of their curriculum may find using technology modeling as a beneficial instructional approach. Once again, the students are presenting ideas through tangible objects. The models add realization as to how the future may appear. Likewise, the models depict the mood by their color and functional parts. The difference in the learner outcomes from simple design sketches and models is visualizing the physical properties. Also, technology models depict the functionality of future systems.

Are there particular skills students and teachers need to possess to build successful models? It is important to understand good construction principles such as keeping components proportional, aligning parts perpendicular, and keeping pieces parallel. These basic concepts illustrate size and space relationships that are essential for a balanced model. Teachers and students should also be knowledgeable of how parts fit together because knowing how to assemble components is an essential part of building a technology model. It may be helpful for students and teachers to review technical manuals or assembly drawings that illustrate how pieces fit together. Technology modeling also enhances a student's ability to measure accurately. Likewise, types of materials to be used when building models are important. Materials such as thin wood, cardboard, plastic sheeting, dowel rod, paper, posterboard, and other relative lightweight materials work well. These materials are easily separated with craft knives, scissors, or coping saws. Such materials can also be formed to make the shape of most desired objects.

The means by which technology models are assessed is essential to understand so students and teachers know the expectations they are to meet. For each model that is designed and constructed, a set of guidelines and parameters need to be developed by the teacher. The guidelines and parameters form the criteria for the students to meet when constructing a model. Teachers may wish to prepare a checklist and a Likert-scale as a means to attain a quantitative evaluation. Because modeling may present some gray areas in evaluation, a checklist and rating on a Likert-scale eliminates questioning as to what was done correctly and what was done poorly. Major points to be considered in technology modeling assessment may include the following: (1) Did the model accomplish the stated purpose? (2) Did the model present an aesthetic appearance? (3) Was the model functional?

Technology modeling is an exemplary instructional practice for the 21st century. This instructional approach will aid teachers in providing a method to teach students about new technological developments in the next millennium. Technology models provide the visual and tangible learning that helps all students comprehend how technology works in our world.

Essay 9

Technology Education is Powerful Teaching

Michael A. De Miranda
Colorado State University
Fort Collins, Colorado

Teachers in the field of technology education develop instructional practices primarily from an atheoretical perspective. Today, however, practitioners throughout education are being urged to make instruction more relevant, hands-on, authentic, active, and student centered. These instructional practices, emerging from research on teaching and learning, have theoretical foundations grounded in the cognitive science perspective on learning and instruction.

Technology teachers argue that their methods of instruction and classroom practices incorporate many of these newly recommended instructional practices. When suggestions for effective instructional change are made, however, a common response is, "We already do that." Yet, these same teachers provide little evidence that instructional practices in technology study parallel recent recommendations for instructional reform. Therefore, in order to position technology education as a leader in exemplary instructional practices, technology educators must squarely position the field in a well-researched theoretical perspective.

Education will come under even greater scrutiny as it moves into the 21st century. Public outcries for changing education are requiring educators to design instructional practices that produce higher level learned outcomes. Political campaign advertisements often level charges that education must meet the demand for setting higher student learning outcomes, and that educators must be held accountable for student achievement of these outcomes. In response to public demand, for example, science teachers identified exemplary practices in teaching science based on theories of learning from the cognitive sciences. Practitioners of science education are being challenged to design instruction that the learner can engage in a variety of cognitively based approaches to learning.

Here the change is driven from a well-researched perspective, then directed to the classroom. In contrast, perspectives on learning and instruction in technology education are developed from an atheoretical position by practitioners and commercial suppliers, following years of trial and refinement. While practices in technology education have demonstrated promise, they have not been grounded in mainstream educational theory. If technology education is to be recognized as a new basic in education, then the technology education profession must join the larger educational community and demonstrate the consonance of its instructional practices in light of current research in education.

There is sufficient evidence to document that most students can recall simple facts, but serious weaknesses exist in students' ability to apply the facts they know, interpret data, evaluate experimental designs, and use specialized scientific and technologic knowledge to draw conclusions. If technology education is to meet the new expectations for higher student learned outcomes, it will require new methods of teaching, new innovative instructional materials, and new approaches to teaching (Bruer, 1993; Educational Testing Service, 1989).

Goodlad (1993) found that American classrooms at all grade levels are overwhelmingly alike and the roles students and teachers assume in classrooms are distinct. Teachers are in control, the center of activity, and they out talk the entire class by a ratio of three to one. Overall, student passivity, individual performance, and teacher control are emphasized, while student participation, cooperation, and peer learning are de-emphasized.

The shift from passive to active metaphors of learning and instruction represents an important theoretical base underlying cognitive-based perspectives on teaching that can serve to position technology education as a leader in instructional practices. The active learner metaphor represents a critical dimension for technology educators to seize and capitalize on as they develop new methods of instruction and instructional materials that exploit the active, strategic, and monitoring processes students engage in during technology learning activities (Gijselaers, 1996).

Instruction in technology education must be metacognitively aware and informed. Metacognitively aware instruction attempts to transfer the self-regulation and monitoring of cognitive functions (memory, process and control of thinking, appropriate application) and the cognitive tools for learning from the teacher to the student. Therefore, when instruction and instructional materials are designed for technology education, they should be designed to help students acquire and integrate cognitive and metacognitive strategies for using, managing, reorganizing mental representations, and discovering knowledge.

The study of technology must place emphasis on developing the students' ability to discover, experience, share, and use knowledge, rather that simply retain it. Thus, learning in the technology education classroom must encourage students to be partially responsible for creating, monitoring, and evaluating their progress. Learning strategies that extend past structured time periods and free students to inquire and create without curricular boundaries are powerful cognitive tools for instruction that we must continue to pursue.

Technology education programs that emphasize social interaction and teamwork show promising results in fostering higher order thinking skills. When students think aloud in front of peers and teachers, it fosters a classroom ethos that encourages discourse, reasoning, and critical analysis. Higher order discourse and thought are cultivated by participation in social communities that value thinking and judgment. Technology education classrooms must communicate these values by making available opportunities for such activities and responding encouragingly to expressions of questioning and judgment (Dominowski, 1998).

The pedagogical shift to metacognitively aware instruction, active metaphors of learning, and the transformation of classrooms into communities of learning is grounded in instructional exemplars from the cognitive sciences. These exemplars, which are evident in technology education, are ceded from theory into practice through complex instructional interventions that emphasize collaborative learning, socially distributed expertise in the classroom, design/engineering models of instruction, and project based learning (Aronson, 1978; Brown, Ash, Rutherford, Nakagawa, Gordon, & Campione, 1993; Brown, 1992; Pea & Gomez, 1993).

Collaborative learning emphasizes social-interaction, promotes a classroom ethos of discourse and critical analysis, fosters student reflection, shared knowledge use, and champions an environment where students are free to inquire and create without curricular boundaries. In technology education, students must be freed from highly structured instructional models to work in design groups, production teams, and distributed expertise models of organizing learning and instruction. These powerful instructional models position the student as researcher, teacher, and self-regulating participant/expert. Socially distributed classrooms foster an ethos of explanatory coherence, rich understanding, and authentic application of knowledge and skills among learners that is negotiated in an environment of joint responsibility. Design and technology approaches to instruction in technology education are precisely parallel to cognitively based design/engineering approaches to instruction that situate the student as designer, problem solver, and builder/engineer. Design and technology activities foster student reflection and debugging of flawed structures of knowledge when applied to external artifacts, and require basic technological literacy and competence toward application and synthesis of technologic knowledge to defined problems. Project-based learning represents a fundamental shift from learning-before-doing to learning-in-doing. In project-based models of instruction, project boundaries extend beyond classroom walls and are designed to connect the learning with a whole or mature learning task or project rather than a fragment or piece of an incomplete task.

Instruction in technology education is varied, yet many exemplary recommendations from research in the cognitive sciences are unmistakable. Although technology education originated apart from the cognitive science research tradition, it appears remarkably congruous with many characteristics of the cognitive science perspective on learning and instruction. Specifically, there is considerable accord between technology education and how one can use the power of cognitive-based instructional models such as collaborative learning, socially distributed expertise, design/engineering, and project based instruction to support student learning-in-doing during the study of technology.

While the instructional characteristics that make up a technology education environment have long been known to people who practice teaching technology, the powerful connections that exist between well researched theories on learning and instruction in the cognitive sciences and technology education are often missing. Teachers of technology have long employed instructional practices that have motivated and extended student learning in exciting classroom environments. It is no wonder that many before us have asserted that the structure of technology classrooms engages a broad range of students in exciting ways.

The future of technology studies in American classrooms can be characterized from tenuous in many circles, to bright and thriving in others. However, what characterizes a powerful learning environment is often not the content under study, but rather how the content is studied. In the study of technology, the powerful nature of how young minds engage both the learning environment and technological content constitute strong evidence for positioning technology education as a powerful teaching/learning leader in the new millennium. Therefore, has the connection between how research is intended to inform practice come full circle in teaching of technology? Can technology teachers emerge as the leaders in placing instructional reform into practice for the new learners of the 21st century? Perhaps the teaching of technology has found its rightful place in the powerful realm of the cognitive sciences.

REFERENCES

Aronson, E. (1978). *The jigsaw classroom.* Beverly Hills, CA: Sage.

Brown, A. L. (1992). Design Experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Journal of the Learning Sciences, 2*(2), 141-178.

Brown, A., L., Ash, D., Rutherford, M., Nakagawa, K., Gordon, A., & Campione, J. C. (1993). Distributed expertise in the classroom. In G. Salamon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 188-228). New York: Cambridge University Press.

Bruer, J. T. (1993). *Schools for thought: A science of learning in the classroom.* Cambridge, MA: The MIT Press.

Dominowski, R. L. (1998). Smart problem solving: How metacognition helps. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 57-68). Mahwah, NJ: Lawrence Erlbaum.

Educational Testing Service. (1989). *National Assessment of Educational Progress.* Washington, D.C.: Author.

Gijselaers, W. H. (1996). Connecting problem-based practices with educational theory. *New Directions for Teaching and Learning, 68,* 13-21.

Goodlad, J. I. (1993). *A place called school: Prospects for the future.* New York: McGraw-Hill.

Pea, R. D., & Gomez, L. M. (1993). Distributed multimedia learning environments: Why and how. *Technological Horizons in Education Journal, 5,* 35-47.

Essay 10

A School within a School: Teamwork at its Best

W. Tad Foster
Indiana State University
Terre Haute, Indiana

For many children, partial understandings of school subjects turn into hopeless confusions and obscure abstractions. Struggling to make sense of the fragile, piecemeal understandings they possess, these children fall further behind each month and year. Comparable experience across multiple subjects leads these students to generalize about their abilities; and in growing numbers they assess themselves incapable of making it through school. Many leave, joining the ever-larger population of dropouts and unemployed teenagers. Many other students simply persist lethargically, learning little, but accepting it as 'just the way school and learning is'—a boring meaningless waste of time. A Report of The Holmes Group: Tomorrow's Teachers (1984, p. 30)

No! The Holmes Group was not writing about any particular large, urban high school when they wrote about the need to reform the teaching profession and teacher education. Nonetheless, they clearly describe conditions that currently exist in many schools across America.

I am going to tell you a story about a high school—a true story. On the first day of school, an assembly is held for all freshmen; and freshmen fill the gymnasium. On the second day of school, a similar assembly is held for the remainder of the student body; and, once again, the student body fills the gymnasium. Why is it that it takes all the seats in the gymnasium to hold the freshman class and the same number of seats to hold the sophomore, junior and senior classes? Where have all the students gone?

This is the general context for the exemplary practice in technology education highlighted in this essay—a high school in serious trouble. A high school struggling with violence, drugs, gangs, teenage pregnancies, low student performance on multiple indicators, and a high dropout rate. A school, placed on probation by the accrediting agency, located in a district that has had several new superintendents, experimented with a private management firm, and eventually, was taken over by the state.

A resourceful vocational administrator in this district, with a relatively significant amount of federal, vocational money, began discussing the possibility of an innovative, collaborative project to be funded by the district, a business/industry association, and a large manufacturing corporation. About 19 years ago, this district administrator was involved in a project called Vocational Education for the 21st Century during which groups of students worked together to explore career options. Later the district became involved in an alternative program for at-risk students using Comprehensive Employment and Training Act (CETA) money. As is often the case, when the funding ran out, the CETA project ended. The director then applied for a school-to-work grant that outlined the Academy model she had been exploring with her business and industry contacts. The proposal was not funded but as a result of writing the proposal, the parties involved became excited by the idea. And in 1996 they began a locally funded school within a school model entitled, The Technology Academy with faculty in-service and curriculum development.[1]

Basically, the idea is a combination of team organization and thematic education that was and is quite prevalent at the middle school level. However, this project had some interesting twists. First, the team of five teachers (technology education, mathematics, physical science, English, and social science) was given almost

1. *As of the writing of this essay, the project is in its third year. There are 15 teachers in the academy with approximately 350 students in grade 9-11. They are working to integrate the program with their TechPrep program and an experimental pre-engineering program. The general opinion seems to be that things are not as positive as they were in the beginning. Some of the reasons given for this are (a) too many at-risk students being assigned, (b) some teachers assigned who do not believe in the academy, (c) growing faster than they can develop curriculum, and (d) losing a district level champion due to an administrative reassignment.*

total control over the daily activities and curriculum for a cohort of 100 freshmen. During the first year, the students were chosen from a group of volunteers but were a heterogeneous group with a full range of ability levels. Second, technology education was given the lead role rather than a supportive one. Third, there was intense involvement of business and industry, and parents. Fourth, the teachers chose to deal with most discipline situations themselves. They were interested in developing an environment of responsibility and group decision-making. In other words, they chose to treat these freshmen as adults.

In a brochure prepared by the teachers to advertise this program, they wrote the following description:

"The Technology Academy offers:

- A program geared to the interests and abilities of each individual student.

- An integrated curriculum focused on the student's career interests.

- Dedicated teachers working as a team to meet individual student needs and ensure success.

- Enhanced learning activities that allow students to relate what they learn in school to career interests.

- Opportunities to participate in job shadowing, internship and paid work experience activities related to their fields of interest.

- High standards for academic achievement and personal responsibility.

- The opportunity to earn college credit while still in high school."

The team of teachers decided to start and end each day with a planning period. Five class periods are sandwiched between these two planning sessions. The teachers decide daily how to deliver the curriculum, which is centered on a set of themes that were selected during curriculum development held during the summer. The first-year curriculum was delivered in a typical machining laboratory, a new computer laboratory (industrial contribution), and three typical classrooms. Of course other labs and classrooms are being used as the program expands.

The on-task behavior, classroom interaction, and level of respect displayed by the students for each other and the faculty typically impress visitors. The classroom environment for the academic subjects is not greatly different in this academy as compared to the rest of the school. The English, mathematics, science, and social science teachers still provide a significant amount of their instruction using traditional methods with some traditional results. However, the major difference is that the entire curriculum is integrated around particular themes. So the instruction in each subject is directly connected to what is going on in the other subjects. There is continuity and a sense of wholeness to what is being taught and the overall methods of delivery.

Almost everyone agrees that the program is a success. So much so, that they have continued to develop the academy into a four-year program. In addition, the district has created other academies (e.g., a sports academy) to capitalize on the power of instruction delivered in relevant and interesting ways.

In talking with a wide variety of the people connected to this project, the following list of benefits to students was identified:

- A decline in dropout rate (e.g., in the first year of operation the students had a 95% attendance rate and approximately 86 were promoted to the 10th grade).

- A decline in unwanted teenage pregnancies.

- A decline in discipline problems, not only because the teachers dealt with most incidents, but also because the number of incidents declined. The teachers, administrators, and outside observers reported that they thought this was because the students were more engaged and interested in what they were learning. They, and the students, reported that what they were learning in the Academy was more relevant, interesting, and fun.

- The students expressed that they enjoy the sense of family. The students felt like they were a part of something important, that their presence was important and that they were valuable in a system notorious for treating people like numbers and non-beings.

The following list of teacher outcomes was identified as a result of discussions with people connected to this project.

- A genuine sense of ownership and involvement that resulted in an increased willingness to do whatever it takes to succeed.

- An increased sense of professionalism.

- A revived interest in their work; a feeling that what they did made a difference.

- A sense of family.

Of course, like most educational innovations/programs, the Technology Academy is not without its problems. Now in its third year of operation, it has become obvious that programs of this nature need a champion at the district level to ensure that the needs of the students and faculty are addressed. A champion is also needed to market the program to the administration in an environment of competing interests and needs. In addition, given the rate at which change is occurring, the teachers have found it increasingly difficult to get time for faculty development and curriculum development. Finally, the vocational director who developed the program now believes it would have been better to delay full implementation and expansion to additional groups of students and teachers until the bugs were worked out. As a result, the second and third years of the project have been somewhat less successful.

Conclusion

Over 100 years ago, Dr. John Dewey ran a school in Gary, Indiana in which he centered all learning on doing. Today, an inner-city high school with a myriad of social, administrative, and academic problems has rediscovered what educational research has demonstrated and what Dr. Dewey knew. When education is relevant and interesting and when education engages students, the students invest themselves in their own education and grow academically and as human beings. By the time a large number of students get to high school, they have become disenchanted with the educational process. Education has become something that must be tolerated.

Teachers, administrators, and outside partners connected to the Technology Academy have discovered the importance of relevance. Learning by doing does not replace learning by knowing. True learning results when learning by knowing is coupled with learning by doing. Students must be engaged by what they are learning. They must see a connection with the world around them, their future and what they are currently learning if we expect them to invest themselves in the educational process. Those involved with the Technology Academy took a significant risk in suggesting to the school and district administration that there was a better way to educate children, even for college-bound students. They even went so far as to suggest a curriculum that put working with one's hands and mind at the very center of daily instruction. The Technology Academy is an outstanding example of the power of collaboration, the power of learning by doing, and the power of a group of teachers who were empowered to act as professionals[2] working with a group of students who were empowered to take ownership of their own education.

2. *Readers interested in a more complete discussion of the need for empowering teachers as professionals are encouraged to read* The Report of the Holmes Group *published in 1984.*

Essay 11

Igniting the Passion through TECA

William L. Havice
Gerald G. Lovedahl
Clemson University
Clemson, South Carolina

Martha Graham, a central figure in modern dance, once remarked, "Great dancers are not great because of their technique; they are great because of their passion." Although there are numerous definitions of professionalism and leadership, those who attempt to define either term generally agree that individuals who exhibit those traits also possess a high degree of passion concerning their life's work. This passion is often emblematic of someone who is approaching Maslow's highest level of needs, self-actualization, a level that is impossible to reach without passion for one's work.

There are numerous techniques available to teach prospective technology education teachers the cognitive and psychomotor content that will be required of them as teachers. However, there is very little agreement as to the best approach for teaching affective attributes, such as professionalism and leadership. Consequently, many students graduate from teacher education programs without the passion required to commit their lives to their profession, as evidenced by the large attrition rate of teachers after only a few years of employment. These new teachers know and can implement many of the techniques in technology education; they are simply lacking passion for their chosen field.

Affective objectives, dealing with aspects such as professionalism and leadership, are particularly difficult to teach within the confines of a classroom or laboratory. One alternative that not only offers the opportunity to teach about professionalism and leadership, but also permits students to see these traits modeled, is an active professional student association such as the Technology Education Collegiate Association. (The Technology Education

Collegiate Association (TECA) is a student affiliate of the International Technology Education Association.) However, despite the numerous advantages of maintaining an active TECA chapter, there continues to be considerable ambivalence among many professionals in technology education towards promoting and supporting active TECA chapters.

Lack of time is the reason most frequently cited for not getting involved with TECA. Perhaps some professionals in technology education are unaware of the many advantages TECA offers to both their students and them. These advantages include (a) development of leadership, (b) cultivation of professionalism, (c) broadening of educational experiences, (d) improved student motivation, and (e) enhancement of student recruitment. All of these advantages contribute to igniting the passion in our students toward the field of technology education. Technology educators who are concerned with recruiting, retaining, and graduating teachers, who will remain active in the field as professionals, may be missing out on the opportunities TECA offers future technology education teachers.

The opportunity for leadership development is one of the most obvious benefits to be found in an active TECA chapter. Future leaders of our profession learn about leadership by participating in TECA activities at all levels, including events on their college campus, regional competitions across the country, and international TECA contests held each year at the annual conference of the International Technology Education Association (ITEA). A college student once remarked that the thrill of competition in TECA events was as great as the thrill he had received from participation in middle and high school athletics. Another young man returned to his college alma mater after several years working as a successful manager of a small business. He described how his experience working with a team to win the TECA manufacturing competition was the most memorable of all his college experiences. He said that the four-hour preparation period required to develop a manufacturing system was his most challenging experience while attending school. Further, he said the challenge of communicating with four or five team members to problem solve, take risks, be flexible, and be adaptable with limited resources was a tremendous educational experience which he has transferred to experiences today. Both of these young men had their education enriched by their participation in TECA events, and even after several years the passion had not subsided.

Students also get involved in the politics of TECA by running for elected office in their local chapters and at the international level. Once elected, they gain first-hand experience in many aspects of leadership. With a large percentage of the current leadership in the International Technology Education Association approaching retirement age, we should be concerned about preparing the next generation of leaders. These prospective leaders need to gain experience, and there is no better opportunity for technology education students to acquire leadership experience than through TECA participation.

Students involved with active TECA chapters develop professionalism as a natural by-product of their activities. Faculty who are involved as advisors to TECA chapters are among the finest professionals in our field, and they constantly model professionalism in their work with the chapters. Students acquire their sense of professionalism from observing and working with these excellent role models, who exhibit a passion for their profession.

Although students have the opportunity for in-depth experiences with tools, materials, techniques, and systems of technology in their school laboratories, and attend numerous lectures pertaining to technology education, they tend to view the profession only through their local perspective. They are, to a great extent, isolated from students at institutions other than their own. Participation in TECA allows students to interact with their peers from institutions across the country, and to discover the similarities and/or dissimilarities among the various programs. Their points of view become much broader through various collaborative efforts, such as publishing the newsletter to be mailed to every TECA student in the country.

Motivation or the lack of it, among today's students is frequently cited as an area of concern among faculty. Victor Frankl, a noted psychologist and survivor of the Nazi concentration camps, once wrote that the last thing a person has control over is his or her attitude. Motivation is largely a matter of attitude, and this attitude can be influenced by activities which students perceive as useful, interesting, and challenging. In programs where there is an emphasis on TECA, motivation does not appear to be a significant problem. This is most likely due to the competition that carries over from the regional and international contests, and which encompasses the entire school year. Students are actually preparing for the contests in their classes throughout the year, with the goal of winning the manufacturing, communication, transportation, problem solving, technical presentation, or technology challenge at the next regional or international conference. Furthermore, many faculty have incorporated aspects of the competition into their class assignments, even going as far as conducting their own technology challenges in the months prior to the conferences.

Recruitment of prospective teachers is a recurring problem, especially in programs designed to prepare technology teachers. Programs that successfully participate in TECA competition at the regional and national levels gain a new level of respect on campus resulting from the publicity that accompanies those successes. This publicity is an excellent public relations tool for enhancing the reputation of the department. Not only are dissatisfied students from other majors across campus made aware of an interesting and challenging major through the ensuing publicity, but also non-teaching majors in the department will often participate in TECA chapter competitions. These students often switch to the teaching field because of the experiences they have had in TECA.

Actually, recruitment is only half of the problem. Retention of good technology teachers is becoming increasingly more difficult. Once again, the sponsorship of a TECA chapter offers some relief. New teachers who participated in TECA as undergraduates are more likely to get involved in sponsoring Technology Student Association (TSA) chapters in the public schools. These teachers are among the most successful in our field, and are more likely to remain in the teaching profession. They truly view what they are engaged in as a profession, not a job. In other words, they have acquired a passion for what they are doing.

Although there are many challenges facing our profession as we enter the 21st century, there is none more important than recruitment and retention of knowledgeable and creative technology education teachers. We cannot survive as a profession without the unceasing influx of highly motivated young professionals—men and women with a burning passion for what they do. The benefits of TECA participation toward instilling a sense of professionalism and developing leaders are undisputed. To that end, talented leaders must be recruited to deliver technology programs in our schools. The students who enter our technology teacher education programs during the first decade of the 21st century will shape the minds and actions of people for many generations. They will be challenged to fulfill a major societal need—to help people understand how technological systems are developed and produced and how to apply technology in an appropriate manner.

Funds must be earmarked by individual institutions and by every professional association affiliated with our field for the support of TECA chapters in all technology teacher education departments. Furthermore, additional scholarship money must be identified and made available to individuals who demonstrate potential for leadership, through active participation in TECA activities. Our profession's 21st century agenda must accept nothing less!

Our students are acquiring much of the knowledge, skills, and techniques needed to be technology teachers. Now, we need to ensure that they also acquire the passion. With passion they will truly be great, and our noble profession will continue to flourish.

Essay 12

Making Connections: Situated Learning in Technology Education

Roger B. Hill
The University of Georgia
Athens, Georgia

It was literally an indictment of our educational system. A young lady in the eighth grade was saying she had absolutely no use for mathematics, that it had no practical application in real life, and that she was tired of studying for tomorrow's test since the material had nothing to do with anything that was of interest to her. All of this came from the mouth of a student who always made A's and B's, who regularly used a microcomputer to research school projects, who planned to become a veterinarian, and whose favorite hobby was shopping. In fact, in the eighth grade, she already had her own checking account that she balanced monthly. The irony was that mathematics had everything to do with what the young lady was interested in, but somehow the connections between math class and real world applications escaped her.

Was this occurrence an anomaly? Do most students appreciate the practical value of school subject matter? Do most young people perceive school to be relevant? In far too many instances, the answer to these questions is a resounding NO. Students go through the motions, do what is necessary to get by, and continue to compartmentalize academic subject matter in discreet packages that have little recognized association with their everyday lives. Even when their lives are full of potential applications for school subject matter, connections are seldom made.

The lack of connections between academic learning and practical application is an issue that has been identified as a concern in school reform studies such as the SCANS report. This is also not a new problem, but one that has become increasingly pronounced in the later portion of the 20th century. Specialization in the production of goods and services and consumer isolation from producers with a burgeoning retail sector in between have created a world where extra efforts are needed to connect classroom learning with workplace applications.

One of the responses to the need for more effective instructional techniques in schools has been the growth and development of situated learning as an element of educational theory and practice. Based on elements of cognitive psychology, situated learning recognizes the significance of prior knowledge, the social and cultural aspects of the learning environment, and the need for relevant contexts or settings for instruction. Another theme sometimes considered in conjunction with situated learning is constructivism—the theory that new knowledge is constructed by learners rather than transferred and therefore is heavily influenced by prior knowledge and context.

Educators, particularly over the past decade, have recognized situated learning as a valuable strategy for effective instruction. In some instances, elements of situated learning have been successfully implemented, but in many others constraints of limited understanding, time, or resources have restricted its use. The merits of situated learning remain, however, and adoption and implementation of situated learning principles are worthy educational goals.

The field of technology education is particularly well positioned to provide situated learning opportunities that enhance instruction in the areas of technology, science, and mathematics. Most technology education programs have the equipment, curriculum, and teacher expertise to significantly assist students in making connections between academic learning and real world applications. In fact, many of the principles of situated learning are a part of the heritage passed along to technology education.

Three aspects of situated learning that represent exemplary practice are currently found in quality technology education programs: (a) new learning is situated so that it is connected to prior knowledge, (b) the context for learning includes the relevant artifacts and processes needed to provide a realistic setting, and (c) learning is situated within a supportive social environment. While these issues are relevant to other disciplines within education, technology education excels in providing these key elements for successful learning.

Prior knowledge is an important issue in providing an efficient and effective learning environment as students come to school with a wide range of prior experience. If assumptions are made that marginalize prior knowledge or expertise, students may become bored and opportunities are lost. If prior knowledge estimates exceed the understanding students bring with them to class, materials presented are sometimes not correctly understood, and applications are limited. For example, many textbooks that present materials related to computer technology include chapters about the basic use of computers including elementary topics such as how to point and click with a mouse. If class time is spent covering such material with students who are already literate about these topics, credibility regarding the instructor's judgement is diminished. Strategies for instruction and selection of material should be based on what students already know so that time is not wasted and efficient learning is facilitated.

Good technology education programs do an excellent job in this area. Not only is the prior knowledge students bring with them to school recognized, but also learning taking place in other classes is considered. Curriculum is structured in such a way that students can build on what they already know and move on to new levels of achievement.

Technology educators have a long history of successfully providing a relevant physical environment for learning. The tradition of the field includes extensive integration of hands-on learning activities that create opportunities for students to construct knowledge using artifacts and manipulatives as they study the content and processes of technological problem solving. Certain topics are addressed through oral presentations and written materials, but they are typically situated within a learning environment supported by activities that allow for experimentation and activity based learning.

A third issue relevant to providing situated learning environments is the social interaction and culture that provides the setting for instruction. It is important to establish a community where learners are participants and interaction with others is encouraged. Once again, this has been a typical element in good technology education programs. Students have collaborated, worked on problem solving activities together, and in many instances been situated within a community of learning that encouraged friendships and participatory interactions that enhanced learning.

Technology education has traditionally excelled in situated learning. Many students have found meaning for academic content within these programs and learning has been enriched. The future also holds great promise, but several concerns are evident including the impact of modular curriculum designs, the need for further integration with other school subject areas, and the increased understanding of the situated learning mechanisms that need to be considered when instructional design revisions are undertaken.

Modular curriculum designs have become quite popular in many technology education programs. In some instances, students are placed with a partner and assigned a set of learning activities to work through on a relatively independent basis. If this model is implemented exclusively, situated learning is limited. Some modular approaches do not provide sufficient opportunities to evaluate and accommodate prior learning and to develop learning communities. Modular units also sometimes fail to include realistic tools and artifacts for students to work with due to space and cost considerations.

As technology educators cross the threshold into the 21st century, one of their greatest opportunities is to better position the field as an integral part of every student's educational experience. One rationale for doing this is the logical role technology education can play in integrating study of the traditional basics with real world applications. Typically this discussion focuses on integration of technology education with mathematics and science. It is also essential, however, for technology educators to address the interface of technology with social studies, language, the fine arts, and other disciplines so that students develop a better understanding of the significance of these content areas. Technology education activities should seek to integrate learning from all of the artificially compartmentalized subject areas still prevalent in schools and provide opportunities for students to see the relevance and importance of academic learning in a technological world.

It is essential for technology educators to be lifelong learners in the area of principles of cognition that are the basis of effective and efficient instruction. Old instructional techniques must be questioned and new strategies explored. This is not to endorse change for the sake of change, but just as competent technologists are always seeking improved processes, technology teachers should be constantly looking for more effective instructional strategies. Technology educators should be cognizant of both old and new theories about learning and how instructional practices are impacted. Approaches involving situated learning, constructivism, or traditional instructional methods should be chosen based on understanding of the strengths and weaknesses of each and not simply applied due to familiarity or faddishness. Technology teachers must continue to be both excellent educators as well as competent technologists for technology education to reach its full potential.

Technology educators also need to question and examine instructional trends within the field. The recently developed national standards provide ideal rationale and support for situated learning in technology education programs. If particular implementations of laboratory design, instructional equipment, or curriculum materials are not conducive to the standards and effective instruction, changes should be initiated. In some instances, significant investments of resources and time will be involved and adjustments will be costly. For the well being of students and the good of the profession, technology educators must move forward to improve programs of study and meet the challenges of the future.

Essay 13

Of Artifacts and Emotions

James E. LaPorte
Virginia Tech
Blacksburg, Virginia

Take just a moment and think about what you remember from your elementary and secondary school days. Visions of a junior prom, breaking a tie score for your team in the final seconds of a basketball game, an unfortunate automobile accident, and wearing a pair of unmatched stockings to school may be among some of the events. It is quite unlikely that you can recall when you first learned what a verb was, when you learned about the Civil War, when you first multiplied decimal numbers, or when you learned Newton's Third Law.

The reason why we remember the former type of events is that they evoked our emotions. Emotions are a key element in our ability to remember the past. Though psychologists tell us that highly emotional negative events may be repressed to the dark niches of our minds, positive emotional experiences are often remembered for our entire lives. In many cases, we are not only able to recall the positive emotional event itself, but we are able to remember the intimate details of the situation in which it occurred, as well as the circumstances that led up to it.

What compels people to want to recall their emotional past? Most often, it is for pleasure. It provides a perspective on life, enabling us to reflect upon where we were and where we are now. It helps us to realize our progress and accomplishments. It enables us to remember times in the past, perhaps times that were happier than the present. It acts as a springboard to recall even more emotional events and thus intensify the pleasure. It helps us remember what we learned.

Photographs are artifacts that help us capture and preserve the positive emotional events of our past. They are effective in this regard because they are visual images that help us reconstruct our memories. As powerful as photographs may be in conjuring up emotions, they often wane in comparison to the actual artifacts from the event. Your first pair of shoes, the game ball that enabled you to become an athletic hero in your school, and the dried petals from the prom corsage can have awesome capability to stir your emotions.

Since the beginning of time, artifacts have played an important part in civilization. Historians use artifacts to identify and describe cultures and make comparisons among them. Artifacts validate the authenticity of historical theory. They are the most tangible and lasting contributions that our ancestors leave for us. They become key to understanding our historical roots. Touching the worn handles on a plow that your great grandfather used to till the soil, seeing the Golden Gate bridge for the first time, or hearing the sound of an old steam locomotive and smelling the burning coal engage our emotional experiences. They are much more powerful than verbal descriptions, pictorial representations, or even multimedia presentations. Experiencing these artifacts directly connects us with their creator through our senses and it stimulates our emotions. Artifacts represent the creative genius and accomplishment of those who have gone before us. They constitute our civilization today. They will be the outcome of our technological achievement in the future.

For years, teachers have used artifacts to make learning more meaningful and to evoke students' emotions. Dioramas of colonial American villages have been constructed in social studies classes using cardboard and sticks. Models of molecules have been assembled in chemistry classes using wooden dowel rods and foam balls. Bridges have been made in physics classes from toothpicks and glue. Three-dimensional works of string art have been created in mathematics classes using nails and scrap plywood. To construct these artifacts, students have used tools such as pencil compasses, razor knives, and hammers. Students have been able to do these things in a regular classroom. Though effective for their intended purpose, they are nonetheless contrived attempts to connect the student to the world outside the school. Rarely do these artifacts make it past the dumpster in the back of the school building. Though they may help communicate what the student learned, the actual learning that occurred in constructing the artifact is often minimal.

Artifacts in the form of take home projects have been a part of the programs that preceded technology education for decades. Not only did these projects naturally lead to emotional involvement by the student; they served as artifacts of the learning experience that could be shared by others, engaging them in the emotion of the experience as well. When done successfully, they embodied the pride of their creator and exemplified accomplishment. In addition, the artifacts were almost always intended to serve a useful purpose, ranging from helping to organize a desk, supporting books, or digging in a garden. Indeed, creating something that successfully serves a useful purpose is a satisfying and emotional experience.

As we begin this millennium, we continue to struggle with the question: "What is the field we have chosen to call technology education?" Whatever it evolves into over time, technology education must uniquely contribute to the education of the students it serves if it expects to prosper. Studying about technology is not a unique contribution. Vignettes about how kerosene lamps and steam engines work, for example, have been a part of social studies for decades. Both have been a part of practical applications in science classes as well.

Computers are certainly not the exclusive domain of technology education. Virtually every school subject has a need for using computers as tools. The day will most certainly come when it will be laughable to think that we once taught students how to use software and how much of the students' time we wasted in teaching such fleeting content. Software programs will inevitably become so easy to use that no formal instruction will be needed. Moreover, we will shake our heads about the instructional modules we designed simply because a particular software package existed. Flight simulators can be used just as well by science teachers as technology education teachers.

We are quite good at providing hands-on instruction for our students and it is admirable that it continues to be a distinguishing feature of most of our programs. In fact, nearly every other subject in the school has tried to adopt a hands-on approach to their instruction, by and large enjoying only meager success even with huge investments of time and effort. Science, for example, has been trying to establish hands-on, laboratory-based instruction as a regular practice for decades and still has a long way to go. But the fact that hands-on instruction is the ideal to which teachers of other subjects aspire means that it is unlikely that it will remain as a unique attribute of technology education in the future.

So what unique contribution can technology education make to the overall educational enterprise in the 21st century? Quite simply, it is the authentic problem solving experiences we have provided for students since the inception of our field, but re-invented to reflect the technological world in which they live now and in the future. Instead of simply reading about our industrial production system, we can actually design and implement one. Instead of simply thinking about how shelter might be provided for homeless people, we can design and build a real, full sized example. Instead of modeling a building out of cardboard, we can build a real building. Instead of just measuring the mechanical advantage of a laboratory block and tackle in a science class, we can build a real one and use it to solve a practical problem that is meaningful to us. Instead of building an automated system from plastic blocks that sorts parts, we can build a real sorting system that solves an actual problem in which we are interested. Instead of experiencing a virtual world through a computer, our students can experience a real world in our laboratories. We are not limited to scissors and razor knives, or to kits and building blocks. We do not need to contrive, simulate, or play let's make believe. We can really do it!

Essay 14

Design—The Creative Soul of Technology

James R. McCracken
Bemidji State University
Bemidji, Minnesota

The small plume of dust settles slowly in the ravine. Sounds of hoof beats and shouting voices have been replaced with the sound of wind passing through the grass. A band of ancient hunters thread their way down to the bottom of a steep, rocky ravine to survey their success. They examine the carcasses of deer they have chased over the cliff.

The animals are hauled up to the plateau and loaded onto skids fashioned from sapling poles lashed together with sinew. The hunters drag the quarry back to the encampment. Living quarters for this band of people are small huts constructed from a framework of sapling branches and poles, and covered with tanned hides of animals from earlier hunts.

Collectively, band members begin the task of processing their latest bounty. A chipped rock-cutting tool is used to skin the carcass. Once skinned, the hides will be scraped with other rock tools, and stretched on wooden racks for drying. Tanned hides are fashioned into crude apparel and used to build or repair huts.

Meat is cut with sharp edged bone tools. Surplus meat is dried in the sun on wooden tripods, or cut into small pieces and mixed with other foodstuffs. This mixture is stored in reed baskets. Bones are scraped clean of meat and fashioned into tools with sharpening stones. Teeth and fur are formed into jewelry, toys, or cultural and social ornaments.

The creation of tools and other devices signifies a defining moment in the emergence of technology. Technology may be thought of as people using knowledge and resources to create objects to meet their needs. The manner in which these people lived and hunted was made possible by the use of these items. Weapons greatly increased their hunting success. Shelter greatly increased their comfort level.

Technology is evidenced by all of the things humans have created throughout history. Look around. The chair you are sitting in, the light used for reading, the CD player, and the clothes that you are wearing are all examples of technology.

By itself, the historical importance of human beings using technology is profound. However, there is another equally profound milestone of human civilization intertwined with the evolution of technology. That milestone is the ability to design. Design signifies the human capacity to consciously make a connection between recognizing a need and developing a solution to meet that need.

Design can be described as the process of creating something useful. It brings a sense of order where before there was only the randomness of nature. Design is a blend and balance of form and function. Function serves as the operational component of design. It represents the purpose of which the designed item does what it is supposed to do, such as the ability of a radio to receive and broadcast a signal.

However, design would be incomplete with only the element of function. Design also includes form, which may be represented by shape, mass, color, and texture. Evidence of form can be seen in the contours of an automobile, or the pattern of a shirt fabric. It represents artistic and esthetic values expressed through lines and surfaces.

Design is an edifice of human achievement, and reflects social and cultural values. This can be illustrated by architecture. As a workplace, an office building functions well by providing privacy, light, heat, and protection from the elements. However, a skyscraper of breathtaking angular lines, reflective glass, and granite facades serve as a symbol of a progressive company or community meant to inspire both workers and passersby.

Design is initiated as a mental process. It its infancy, it is invisible to the eye, yet readily evident with an end product. A solution for a skyscraper begins as a dream in the mind of the architect. Technology is typically manifested in physical objects. The building is only a set of plans on paper until a builder transforms the dream into dimensional reality with bricks and mortar.

In this way, design can be considered the creative soul of technology. As a human soul is to the body, design is to technology. It is important to understand the interdependence and complimentary nature of technology and design. Like the inseparable relationship between body and soul. Technology is incomplete without design. Design cannot be fully appreciated without an understanding of technology. If technology is to be fully understood, then the concepts of design need to be understood.

Technology teachers around the globe have increasingly recognized the importance of this interdependence. Educators from the United Kingdom have identified design as the lens from which to study technology in their school systems. Deemed nationally important, Design Technology is taught to all students, at both the primary and secondary levels. Design has been identified as a major process of technology in the Technology for All Americans project in the United States. Recognition of the importance of design as part of technology education is justly deserved.

The essence of design is outlined in the Technological Method Model. In a nutshell, the Model outlines the steps used in creating or designing a technological device. It traces the creative process through problem definition, identifying possible solutions, selecting, testing, evaluating, and monitoring the implementation of a solution. To understand design, students must understand the Technological Method.

Design provides a unique approach to studying technology. As a common denominator, it is equally present in designing a mass transit system, consumer electronics, or new biotechnology products. Design is connected to environmental, social, and economic factors. Cutting across technology with a universal perspective, it is also timeless. Its origins are in the dawn of civilization, as illustrated by the band of hunters described earlier. It will be here as long as humans face the challenges of the future. Design can be a delivery mode to teach any type of technology.

Imagine a consumer shopping for a new digital camera with an understanding of design and technology. Browsing through the store display, they are confronted with a dizzying array of choices.

Holding a camera in their hands, they evaluate the ergonomic features such as button position and operation. They ask functional questions about the flash and adjusting the image. The sales person explains the warranty, service, and expected product life span. The consumer is able to make an educated decision on purchasing a camera.

An appreciation of design goes far beyond consumerism. Design is the lifeblood of economic security for a company. Nothing more poignantly illustrates this than the 3M Corporation, a company with a worldwide reputation for innovation in product development. With corporate goals of maintaining market share, a constant stream of new products needs to be designed. The philosophy of 3M management is that 30% of earnings each year must come from technological development in the last five years.

Given the fact that it typically takes hundreds of initial ideas to ultimately come up with one idea that actually has market potential, it is mind boggling to consider how many initial ideas 3M employees generate. This example speaks to the insatiable appetite that companies have for employees with a design flair. It is important for all of their employees, not just engineers, to have an eye for design.

Think of design from the perspective of a learner. Design naturally fosters higher order thinking, inquiry, and problem solving. As students tackle a design based learning activity, they access a learning environment without horizons. They learn from an inquiry perspective the nature of searching out solutions. They are not limited in creative vision by the blinders of only certain materials or processes.

Teachers must understand the nature of design too if they are to optimize learning through design. Design is not a one shot process. If it isn't recognized as an ongoing process, the educational value will be shortchanged. Learning stops when the design project stops. Too often learning activities such as bridge building don't take advantage of repeated testing, redesign, and refinement.

Imagine flying over a wind swept prairie similar to the one inhabited by the ancient band of hunters. You have returned to the present from prehistoric times. Zooming down, you find yourself in the cockpit of a race car. Low to the ground, the countryside glides by. Not a typical racer built for speed, it is a vehicle built for achieving maximum fuel mileage. What else makes this racer unique is that it was not built by professional engineers, but by a team of high school students. Some of the vehicles can achieve a remarkable mileage rating of over 700 mpg.

The racecar epitomizes the use of design in technology classes. The basic premise of the design problem is simple. Design and build a vehicle powered by a standard three horse gasoline engine to safely transport one human being with the highest miles per gallon possible. This design challenge is an activity both rich in educational experience and the breadth of technology it encompasses.

Calling upon the use of the Technological Design Method, students began the design process many months prior to race day. A quick check of the cars shows an eclectic variety of shapes, colors, and mechanical concoctions. No two are alike. Each vehicle represents a philosophy or strategy chosen by the students as the optimum solution.

Students are their own teachers for this activity, with the traditional teacher serving as a facilitator. Students become independent, self-guided learners—the very type of learners society needs to face the ever-changing future. The sequence of design used by modern day technology students parallels the strategies used by the ancient hunters. Both used the creative process to design solutions based on daily needs.

Students quickly learn that design is not a one step process. Just as ancient hunters gained design insight from evaluating each weapon built, so too students test each component of their design, from carburation devices to chassis construction. Failure is common. Subsequent ideas are constantly tweaked to maximize vehicle performance. Reflective of the design process, improvement is constant and incremental.

These students have become intimately familiar with technology through design. They understand the roots of technology, and how it is based in problems of everyday life. They have developed expertise in a multitude of technologies, and the vehicle is testimony to their level of technological literacy. Conceptually, this design problem has provided an invaluable insight into the process of learning and problem solving. They understand the close relationship between design and technology. As individuals, they are well poised for life in the next century that will have an unquenching thirst for new solutions to human needs.

Essay 15

Electronic Portfolios

Edward M. Reeve
Utah State University
Logan, Utah

I walked into Mr. Petersen's ninth grade technology education classroom. The classroom was perfectly quiet and dimly lit. The only sounds to be heard were a faint "hum" coming from the multimedia computer and LCD video projector attached to it. However, all of this was about to change. The members of the Satellite Gaming Company were getting ready to present their electronic portfolio on the development of their satellite.

Early in the semester, Mr. Petersen divided his technology education class into groups of three to four students. Each group was assigned a design brief challenge—to research and design an item/object (e.g., a vehicle, living quarters, a satellite) for use in outer space and then to present their findings to the class using an electronic portfolio.

For this assignment, a group of students with a common technological interest asked Mr. Petersen if they could work together. Mr. Petersen agreed that they could. The common interest of this group was that they all enjoyed playing networked computer games using their modems. However, they were all frustrated by the slow speeds of their modems. They wanted high-speed gaming and felt that this could be accomplished by using a satellite in space. And so began the formation of the Satellite Gaming Company to research and develop sending a new satellite into space to provide high speed gaming using digital signals.

The group thoroughly understood their design challenge and the steps required to complete it. However, they were confused about this thing called an electronic portfolio, what is it? They asked Mr. Petersen to explain. He explained that it is a type of document or work that displays the achievement of an individual or group in the completion of a project, product, or system. Typical elements in a portfolio include (a) a description of the problem or challenge, (b) a brainstorming of possible solutions, research, and resources, (c) the steps taken in choosing a solution, (d) implementing the solution, and (e) evaluating and testing related to the development of the product, process, or system. He further explained that in the past, portfolios were limited to the technology of the times. Most portfolios were notebook print type documents on paper, with maybe a few pictures here and there.

But the times have changed, he explained. Today, most information is transmitted in an electronic format. An electronic portfolio uses today's technology and contains many items that do not fit into a traditional notebook type portfolio. The electronic portfolio can use multimedia techniques to showcase students' achievements. It can contain such things as sounds (e.g., music, speech), live video (e.g., presentations, documentaries), still pictures, graphics (e.g., drawings, charts), links to Internet sites, and interactivity.

The members of the Satellite Gaming Company were excited about their design challenge and the opportunity to create an electronic portfolio that exhibited their work. They knew the importance of planning and quickly began to develop a plan of action for creating their portfolio. They knew that they would have to continually document their work and progress. They also knew that a script or outline that described the major elements of the portfolio would need to be completed at an early stage in the project. They faced many challenges as they began to plan their portfolio.

Their first major challenge was making sure that they had a good multimedia computer they could use to create their electronic portfolio. They knew the computers from last year would not be able to handle what they were planning to do. They also knew that Mr. Petersen had ordered four new computers that would be arriving shortly. But they wondered, would the new computers be multimedia computers? Would they be capable of running the authoring software they needed? Would they contain sound cards, lots of RAM, lots of hard drive space, and come with speakers? They needed to know.

They were in luck. At the end of the last school year, Mr. Petersen made a presentation to officials of the school district on the need for new computers in his technology program. In his proposal, he explained that even though his technology education program already had some multimedia equipment (e.g., a video camera, a digital video camera, and a video projector) he needed new multimedia computers. He commented that in the next school year his students would be making electronic portfolios. He explained that electronic portfolios were great learning tools and highlighted many of their benefits. He discussed how portfolios required students to document their work using hardware and software related to current electronic communication technology. He also stated that portfolio development encourages students to critically think and reflect on their own work. Furthermore, he related that portfolios are records of learning and growth that provide meaningful documentation, which can be used to assess students' abilities. Finally, he noted that electronic portfolios can be used to show others, including parents, the community, and even the world (he planned to put his students' portfolios on the Internet), what his students had learned.

The district's officials liked Mr. Petersen's proposal, including his commitment to attend a summer in-service workshop on making and using multimedia in the classroom. His proposal was approved and he was able to buy four new multimedia computers and accompanying software for his technology program. He purchased Pentium-based multimedia computers that came equipped with 256MB of SDRAM, 14.4GB hard drives, and DVD-ROM drives. One computer came equipped with a CD-RW so that students could burn their own CD-ROMs. In addition, he purchased multimedia-authoring software that students could use to create their electronic portfolios.

The Satellite Gaming Company's members quickly learned how to use the authoring software. They were highly motivated and worked feverishly on their design challenge of developing a gaming satellite. They planned their electronic portfolio in detail. The portfolio would document their work on designing a gaming satellite, as well as present some general information on satellites. They decided to save their presentation to CD-ROM and show it to the class using the LCD video projector.

The Satellite Gaming Company's members decided at an early stage that their portfolio would be the best of all the groups in the class. Their electronic portfolio presentation would begin with a short QuickTime movie (downloaded off the Internet) of a thundering rocket carrying a satellite into space. They would then show a PowerPoint presentation on the history and purpose of satellites, including a visit to NASA's web site. Next, using graphs, they would introduce the audience to their problem, showing how the slow bandwidth speeds of modems limited high-speed multi-player gaming.

Their presentation would document their research into satellites. Still video pictures obtained from textbooks and from the Internet would be used to show a variety of satellite designs. Sketches that documented their early developmental work on the portfolio would be shown, followed by actual working drawings of their final design. Still and motion video would document the work of the group as they built a mock-up of their satellite. Finally, the highlight of their presentation would be a 3-D animation that showed their satellite operating in space.

The Satellite Gaming Company's members were ready; they had completed their electronic portfolio presentation by the due date and burned it to CD-ROM so that they could all take a copy home to show their friends and parents. The class was ready. The group's presentation began with the thundering of a rocket lifting into space and finished with a 3-D animation of their satellite in operation. When they finished their presentation, the class applauded—the Satellite Gaming Company's members had done their job.

The bell rang and the students started to leave. As Mr. Petersen turned the lights back on, he noticed the principal in the back of the room. He remembers inviting her to the student presentations, but he really did not think she would attend. As he approached her, Mrs. Benson was all smiles and immediately complimented him on the fine job his students had done on their design challenge. She was impressed by the active learning and motivation that was evident in the group's presentation. Mrs. Benson commented on the quality of the presentation and said she wished she could show it to others. Mr. Petersen quickly reminded her that it would be on the school's web server tomorrow and that she could access it anytime on the Internet.

As Mrs. Benson left the classroom, she thanked Mr. Petersen again, this time for not retiring. Even though Mr. Petersen had enough tenure in the district, he had decided to stay on because he was excited about learning how to use the new technology. He responded jokingly, "I would have retired, but you bought me that digital camera and now I have to make multimedia presentations with my grandchildren in them for Christmas." They both laughed.

As we prepare for the new millennium, we can be assured that our reliance on all forms of electronic communication will continue to grow and help bring people of the world closer together. One form of electronic communication is the electronic portfolio. Electronic portfolios can provide students with basic skills needed for the 21^{st} century, including skills in researching, designing, brainstorming, identifying, implementing, and evaluating and testing. I recommend that all current teachers of technology receive in-service training in electronic portfolio development and that all future teachers of technology receive this training at the pre-service level.

Essay 16

Service Learning

Edward M. Reeve
Utah State University
Logan, Utah

While most high school students were still in bed, David and Emily had just spent their Saturday morning working at the local food bank. Why were they there? Had they been in trouble and required to do community service? No, they were actually students in Mr. Harper's communication technology education class working on their service learning assignment.

In his 1961 inaugural address, President John F. Kennedy stated, "And so my fellow Americans: ask not what your country can do for you—ask what you can do for your country." In this statement, he was pleading for Americans to become involved in their country. One of the best ways to become involved is through public service. Today, teachers can help their students become involved in their community through something known as service learning.

Service learning is a form of experiential education. It is a method of teaching and learning that combines academic work with service to the community. In a broad sense, it refers to all forms of out-of-classroom learning, such as internships, leadership development, apprenticeships, and cooperative education. In a service learning situation, students are given the opportunity to complete meaningful community activities that allow them to grow personally through the intrinsic rewards of helping those in need.

Service learning provides students with many benefits. The Communications for a Sustainable Future (CSF) supports a web site and identifies the following benefits of service learning:

- increases retention;
- provides quality education;
- increases the relevancy of education to students 'living in a real world;'
- enhances personalized education for students;

- teaches positive values, leadership, citizenship and personal responsibility;
- empowers students as learners, teachers, achievers and leaders;
- invites students to become members of their own community;
- teaches job skills and prepares students for careers after college;
- encourages faculty to be innovative and creative in their teaching;
- contributes to a university's outreach efforts to the local community, the state and beyond;
- increases campus-community collaboration and partnerships;
- helps with community education; and
- contributes thousands of hours of service to people in need, non-profit agencies, private sector companies, non-governmental and governmental agencies. (1998a, p. 1)

On a trial basis, Mr. Harper had decided to integrate a service learning project into his communication technology education class. He had attended a school in-service workshop on service learning. In the workshop, he learned that a successful and effective service learning project involved three basic components: preparation, the actual service, and a time for reflection (Communications for a Sustainable Future, 1998b).

Mr. Harper presented the unit on service learning to the class. He explained the concept of service learning and provided the class with an example. In his example, he discussed the service learning project completed by the construction technology education class. In that class, the students had mass-produced large sets of wooden dice that they presented to the various elementary schools in the community. The dice were used as teaching aides to help students learn their basic math and counting skills. Furthermore, in the service learning project he was proposing, he discussed that the class would have to investigate the needs of the community, while keeping in mind the major goals and objectives of the course.

Mr. Harper's students learned about service learning and began their preparation. They decided to choose only one service project and work on it together. A brainstorming session was held and various community service projects were discussed and investigated. After looking at all the possibilities, the students decided that their service project would involve helping the local food bank.

The communication technology class members wondered how they could help the local food bank. What could they do? They began by finding out more about the food bank through direct contact with its director. The director explained all about the food bank, including information on whom they served and where they got their food. But more important, she explained their needs. She told the students that since the food bank was only a few years old, not many people in the community knew about it, including the people who needed it most. She also explained that there was always a need for more food and for volunteers to help at the food bank. Finally, she volunteered her time to help the class in any way she could.

In preparing for their service project, the class looked at some of the required activities in the communication's course. One of their major activities was a video production; another activity was in the area of desktop publishing. Also, the class produced a weekly video program that was shown to the entire school over the monitors located in each of the school's classrooms. These activities helped the class define their service learning project. The class divided into three groups and three service learning activities were identified and planned. The service learning activities would include (a) the development of a video for broadcast on the local cable access channel, (b) a short documentary on what it felt like to volunteer at the food bank, and (c) a newsletter about the food bank.

The service activities chosen by the students of Mr. Harper's communication technology education class were challenging, exciting, and meaningful. The first group of students began planning an overview video that would show how the local food bank contributed to the good of the community. Their 15-minute video production would contain a series of interviews. The director of the food bank would provide an overview of how the food bank operates and how it benefits the community. Other interviews would focus on large and small donors to the food bank. An interview with a representative from the local cheese plant on why they donate to the food bank would be featured, as well as an interview with the average citizen. Finally, the group would try to arrange a special interest interview from someone who directly benefits from the food bank.

This group began the planning of their video. A script was developed and group responsibilities were assigned. A major responsibility for all the group members was making sure that they knew how to operate and use the equipment needed to make and edit the video. Other responsibilities included contacting the cable company to find out the requirements for getting a message freely placed on the access channel and developing interview questions for those who would appear in the video.

The next group of students chose to make a documentary video on what it "felt like" to do volunteer work. This documentary would be shown on the weekly news show that the class produced. Two members of this group, David and Emily, volunteered to work at the food bank and reflect on their experiences. They also wanted to get to know some of the other volunteer workers and find out why they got involved in community service. Other members in the group would help in the production of the video, which would be shot on location.

The final group of students would produce a newsletter. It would be distributed free of charge to residents in low-income neighborhoods in the city. Using their desktop publishing program, they developed a newsletter about the food bank. Their newsletter included such things as pictures of the food bank, hours of operation, types of services provided, help needed, and an interview with the director.

At the end of the semester, the class members were given the opportunity to reflect on their experiences. The first group's overview video was a success and is still being shown on the access channel. Members of that group have become school celebrities;

their classmates constantly chide them that they saw them on TV again. The cable company manager was impressed by the quality of the video and asked Mr. Harper if his class was interested in doing any more projects. The director of the food bank was also impressed with the video and noted an increase in food donations and calls from people wanting to help. When asked about the project, the student's comments ranged from, "a lot of work," to "a lot of fun." They all agreed that they liked seeing their video on TV; it made them feel like they had completed an activity that really mattered. It was the first time any of them had ever done anything to help the community.

The next group's video focused on what it felt like to volunteer at the local food bank. Since David and Emily had never volunteered for any type of community project, their thoughts and ideas of community service were limited. They initially thought that it was only for youth offenders who were required to do it.

David and Emily learned a lot. In their video they were able to reflect on what community service means and what it means to be a volunteer. They learned that volunteering made them feel good inside, a feeling that was hard to explain. They found out that others did it for the same reason, because it made them feel good. However, their unexpected in-depth interview of a young single mother who used the food bank made them reflect and realize just how good they really had it.

The group who made the newsletter passed it out after school to families in the community's low-income neighborhoods. In the making of their newsletter, the group members learned about the day-to-day operations of the food bank. They learned that when other members from the community found out about the food bank, many said, "they would be willing to help." For example, when a local printer found out what the group was doing, he offered to print their newsletter free of charge. The group also learned about other services in the community available to those in need. For a few members in the group, it was their first time in a low-income neighborhood; it was not what they expected. Their biggest surprise and greatest learning experience came when they unexpectedly stopped for snacks. One of their group members lived in that neighborhood.

Mr. Harper's communication technology education class learned a lot that semester. As he reflected on the class's achievements, he knew that service learning could also be integrated into the other technology education courses he taught. He had experienced firsthand the benefits of service learning and he liked what he saw. He started to revise his technology education curriculum so that it included a service learning component. He began working on his curriculum revisions during the break between semesters.

Mr. Harper also became involved in service learning by volunteering to help remodel the community center. This involvement provided him with a new type of personal satisfaction that he had previously not experienced. It also provided him with new friendships, and gave him additional ideas on how to incorporate service learning into his other technology education courses.

I recommend that we provide all technology education teachers with the knowledge and skills needed to incorporate service learning into their curricula. This should be done at both the pre-service and in-service levels. Of all its benefits, I believe the most important aspect of service learning is the opportunity it gives us to give back to the community in which we live. Don't you believe that is important also?

REFERENCES

Communications for a Sustainable Future (CSF). (1998a, October). *What are the benefits of service-learning?* [On-line]. Available: http://csf.colorado.edu/sl/

Communications for a Sustainable Future (CSF). (1998b, October). *Just what is service-learning, anyway?* [On-line]. Available: http://csf.colorado.edu/sl/

Essay 17

Systems Approach: A Clear View from the Mind's Eye

Brigitte G. Valesey
International Technology Education Association
Reston, Virginia

People are immersed in created systems. For the movie enthusiast, there are entertainment, video, and digitized sound systems. There are vehicular, clothing and even equipment storage systems for the athlete. The homeowner depends on security, heating and cooling, lighting, structural, and even sleep systems for a comfortable home environment. The car owner relies totally on the functioning of a variety of systems: fuel, brake, electrical, sensing, and propulsion systems; when a car malfunctions, its owner is often rendered helpless. People need to develop technological literacy to make sense of the complexities and interconnectedness of systems.

To understand systems is to see the world as an amazingly complex yet interwoven framework of planned innovations and incidental occurrences. Students with little understanding of systems may be overwhelmed by new gadgets and processes or frustrated by what does not work in their material world. Students who understand systems see basic relationships between parts and technological progressions in products and processes. The connections between telephone, beeper, and cellular phone, for example, become more evident when a person understands the common inputs, processes, and outputs that make up this progression of systems. Conversely, students who are unfamiliar with systems will view the same communication systems as discrete, if not isolated technological developments without relationships.

Some students are overwhelmed by the preponderance of human created systems, while other students are energized by curiosity about systems. Students who think in terms of systems quickly go into high gear to solve practical problems as they arise. Familiarity with the nature of systems facilitates technological problem solving; students can break down problems by analyzing system inputs, processes, and outputs. Patterns develop and relationships form as they investigate systems. Students can better understand how micro-level operations affect macro-level processes from a systems perspective. For example, technology students designing and developing a security system quickly realize that the system's individual electronic circuits are actually smaller systems. These subsystems accept inputs from other parts of the system, process the inputs, and produce specific outputs such as alarms or flashing lights. When the larger circuit does not operate, students can analyze the circuit in terms of subsystems and troubleshoot the circuit. Students who have not studied systems see an amalgam of mysterious parts embedded on a circuit board. The board either works or does not work; without systems, the world is often nothing more than an overwhelming assemblage of black boxes. The trend toward miniaturization and specialization of these black boxes adds to the mysteries of systems.

Given a systems orientation, students may better comprehend the interconnectedness of concepts and content related to other subjects. For example, one team of technology education students studying plant growth in controlled environments had difficulty understanding hydroponics. After additional research and consultations with their teacher, the students realized that hydroponics could be studied from the systems perspective. Now, this mysterious hydroponic setup was actually a system made up temperature-controlling, watering, monitoring, and structural subsystems that required further study. In this context, they conferred with local experts in horticulture and even physics. These students became more and more enthusiastic as they delved into the various systems that enable plants to grow in a soil free environment. These students began to understand how such subsystems must work in harmony to provide optimum conditions for hydroponic plant production. They learned that various processes can be explained in terms of systems and that natural and created systems are closely related.

Students who are conversant with systems understand relationships between parts and their interdependence. To twelfth grade student, Ann, her car was a 3,000-pound conglomeration of sheet metal, castings, hoses, and wires that regularly failed. Her classmate, Brooke, encouraged her to think about how different systems in the car worked and encouraged Ann to ask questions: "Could tire pressure affect gas mileage?" "Why is it that when I got the battery replaced, the car ran poorly?" Brooke would respond with explanations of how the automotive parts worked together and how the output of one subsystem was also the input for another one. Ann began to understand that the systems in her car were interdependent and when one system malfunctioned, it affected one or more other automotive systems. Also, Ann learned to ask questions about the systems in her car to gain a broader view of how her car functioned and what she needed to maintain to improve its performance. For Ann, the systems perspective unveiled some of the mysteries surrounding her vehicle.

Sometimes students are frustrated by the complexities of this "systems thing." Scott was one such student. He and his teammate were researching materials technology in order to develop a materials based system and present key concepts to the class. Scott was overwhelmed by the scope of the topic. The teacher and Scott's teammate had many conversations with Scott about how he could examine this topic from a systems perspective. It still made no sense to Scott. Then, one day he rushed into class and remarked, "I have the most important core technology topic! Without an understanding of materials technology, none of the core technology systems our class is studying could be developed!" Scott had realized that the systems they were studying, such as mechanical, electrical, structural, and optical were connected to his study of materials technology. This cognition was possible due to his conceptualization of systems.

Systems thinking forms a habit of mind—students can analyze technology in terms of systems, describing technological phenomena and analyzing the failure or success of systems. Some students can quickly break down the complexities of a new technological breakthrough by thinking in terms of systems. Stephan, who often struggled with literary compositions and historical theses, was adept at grasping the use and significance of new developments in informational technologies. He was able to see how innovations fit in with our existing systems, and could figure out how they functioned from a systems perspective. Stephan would propose future applications and suggest spinoffs; he was constantly thinking about systems that hadn't even been created. For Stephan and students like him, a systems perspective enabled him to understand new technological developments and to anticipate the future.

Students who develop an understanding of systems and who use this approach may be better prepared to address uncertain futures. For example, students who are familiar with transportation subsystems (propulsion, guidance, and control) can apply this information to alternative energy powered vehicles, submersibles, or even space vehicles. Conversely, students who think of a vehicle as simply a single artifact such as a car, plane, train, or submarine, may not be able to make broader connections. The latter students may not have the cognitive foundation from which to make the knowledge leap to understand new and even more complex systems in their future.

Technological studies afford rich opportunities for students to learn about and experience systems. Students engage in multisensory learning activities that involve designing, developing and producing, using and managing, and assessing a wide range of systems. Their experiences are coupled with content that solves the mysteries surrounding systems designed to convey information, alter the natural world, or provide energy and power, transportation, and products. The *Standards for Technology Education: Content for the Study of Technology* (International Technology Education Association, 2000) presents systems as a major concept in the fundamental knowledge, processes, and contexts associated with technology. Systems help students learn relationships that contribute to their technological literacy.

Systems are highlighted also in science content standards; systems are a big picture idea and unifying concept. According to the *National Science Education Standards* (National Research Council, 1996), "students can develop an understanding of regularities in systems and by extension, the universe; they then can develop an understanding of basic laws, theories, and models that explain the world" (p. 116). So, an understanding of systems in the natural world may help students comprehend relationships that explain what occurs or what exists. Students learn about many different natural systems—human body systems, ecosystems, and climate systems—that are often impacted by technological systems. Systems are essential to study in order to understand both the natural and created world.

An understanding of systems will continue to be important in developing student understanding of technology and in career preparation. Is it possible to be technologically literate without understanding the existence of systems and how they function, even at the most basic of levels? Effectively adjusting the temperature in the office, setting up and using communications equipment, traveling to and from work, and coordinating activities by electronic means involve some understanding of systems. Students who graduate from high school without an understanding of systems will suffer from more than technological illiteracy; they are destined to be highly dependent on others to select, use, and maintain systems.

Technological systems are becoming more complex, more integrated, more miniaturized, and highly specialized; people depend heavily on these systems as they perform daily activities. Technology education prepares students to understand the created systems around them and develop ways of thinking that helps students decipher the mysteries of systems. It may be one of our field's most valuable contributions . . . to prepare students with a clear view from their mind's eye.

REFERENCES

International Technology Education Association (2000). *Standards for technology education: Content for the study of technology.* Reston, VA: Author.

National Research Council (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

Essay 18

The American Technology Honor Society

Rosanne T. White
Technology Student Association
Reston, Virginia

No aspect of individual endeavor is untouched by human kinds' technological accomplishments. Since the dawn of civilization, people have been working within intricate systems in the natural world to improve their lives and solve their problems. Technology, in its purest form, has been around that long. It represents the ability to design using limited resources, the ability to bring ideas into fruition, the ability to make imagination real. (American Technology Honor Society Manual, *National Association of Secondary School Principals & Technology Student Association, 1996, Section 1.1*)

Technological literacy is a hallmark of the 20th century. Computers, lasers, wireless phones, satellite TV, MRIs, DNA analysis, smart cards, and the Internet all were unknown 35 years ago. Now they are ingrained in our everyday life. Some aspect of technology touches every job, and most people interact on a daily basis with some technological process or product. The student who is technologically literate, who understands the origins of existing technologies, and who can use the tools of the modern world to solve problems is well prepared for life and work in the 21st century and helps ensure that the technological innovations of tomorrow occur. The American Technology Honor Society provides a unique venue to foster student achievement in an academic setting and cultivate success in the future for young people across our nation.

The American Technology Honor Society (ATHS) was created in 1995 when the National Association of Secondary School Principals (NASSP) and the Technology Student Association (TSA) formed a partnership to address the need to prepare America's students for life and work in our increasingly technological world. The combined natures of these two nationally recognized organizations effectively support the mission of ATHS, which is to promote and recognize in students technological literacy, including the creative and responsible use of technology, scholarship, commitment to service, and leadership.

NASSP represents more than 40,000 middle level and high school administrators, and 58,000 student activity advisors. Since 1916, this association has demonstrated its commitment to enhancing national school quality and providing professional leadership to meet the changing needs of our world.

TSA was established in 1978 for students with a strong interest in technology. At the middle and high school levels, TSA membership channels students' enthusiasm into a national program of activities and competitions that encourages the development of students as leaders and problem-solvers. At the elementary level, TSA provides a technology literacy program that is integrated into a school's existing kindergarten through sixth grade curriculum.

Since ATHS was first launched in schools, NASSP and TSA have continued to work together as a team to reach students across the country and improve the program. Ongoing outreach efforts to members of NASSP and TSA have increased school and student exposure to ATHS, as has information that is available to individuals and educational institutions via Internet web sites held by ATHS, NASSP, and TSA. Recent round-table discussions with educators, a student task force, and emerging business connections have resulted in program enhancements for students and schools.

ATHS was designed to reach all students in secondary schools across the country. The elements of the ATHS mission—technological literacy, scholarship, service, and leadership—are promoted in young people through school recognition for achievement, student and faculty involvement in a school's technology program, and school contact with business, industry, and the local community.

Any public or private middle level school or high school is eligible to establish a chapter of ATHS. To form a chapter, a school must (a) select a faculty sponsor; (b) create an ATHS school council that will select, guide, and review the status of student members; and (c) have Internet access, or a clear plan for establishing such access. An annual school affiliation fee is required.

Any student attending an ATHS chartered school may pursue membership in ATHS. Eligibility for the entry level, or the *candidate* status, is based on a student's potential to meet the criteria for full membership. Students advance to the *associate* status and then to the *scholar* status by meeting the designated criteria for technological literacy, scholarship, service, and leadership at each given level. Candidates and associates pay modest membership fees; there is no membership fee for scholars.

Once an ATHS chapter is up and running, the faculty sponsor provides guidance to students as they work to meet requirements designated in the four membership criteria areas:

- Technological literacy

  a) skill in the use of technology

  b) the ability to apply knowledge, creativity, and resources to solve real world problems

  c) an understanding of the role of technology in our world.

- Scholarship

  Above average academic performance, which is defined as a cumulative GPA of 3.0 or better on a scale of 4.0, or equivalent standard of excellence.

- Commitment to Service

  The use of technology to improve or benefit the school and community.

- Leadership

  Independence, confidence, integrity, decision-making skills, and initiative. (Section 2.8)

In order to help young people reach their highest potential in school and to prepare them for the demands of future challenges, ATHS promotes achievement in each of these criteria areas equally. Technological literacy is, however, the primary component of this program and also is what makes ATHS stand apart from other honor programs. In addition, of course, technological literacy is a vitally important skill for success in our increasingly technology-oriented world. For these reasons, the technological literacy criterion of ATHS is core to the program. It is promoted through the structure and activities of the chapter and provides opportunities for students to do the following:

- Understand and use technological processes, information, resources, and systems
- Apply practical problem solving/design techniques through a creative process
- Understand and appreciate the importance of fundamental technological developments
- Know and appreciate how human ingenuity and resources combine to meet human needs and wants
- Appreciate the interrelationship among technology, cultures, the environment, and other human endeavors
- Understand and assess the issues and outcomes of technological activities
- Understand the necessity of lifelong technological learning in order to adapt to changing environments and situations related to the home, work, and leisure. (Section 3.0)

In addition, the student should also recognize that educational technology tools are highly useful and applicable to all aspects of life.

ATHS is accomplishing its mission when technological literacy, scholarship, service, and leadership become ingrained in students through the program. This is happening now in ATHS chapters across the country as students, encouraged by recognition for their technological skills, are motivated to new heights in their school lives.

Also, the reach of the mission is beginning to have greater scope, particularly as the program has a positive impact on school instructional programs, community connections with schools, and the development of relationships between schools and business and industry. The benefits range from a vitalized and more relevant school curriculum to an improved school system and a highly skilled future workforce.

An exceptional educator uses her role as a teacher to do much more than impart subject matter. She relates that subject to the larger world. In this fast-paced, increasingly technological world, the educator must make teaching and learning relevant. Technology, and all that it encompasses, can be integrated into the school instructional program in much the same way it is integrated into our lives. And it can produce tremendous benefits. The challenge for the 21st century is to ensure that technology becomes as important in the realm of education as it is in the world at large. The American Technology Honor Society takes a step in that direction.

REFERENCE

National Association of Secondary School Principals & Technology Student Association. (1996). *American technology honor society manual* (1st ed.). Reston, VA: Author.

Unit III

OUR 21ST CENTURY AGENDA

Essay 19

Technology Education Supervisors: An Endangered Species?

Jerry Balistreri
Anchorage School District
Anchorage, Alaska

The technology education profession enjoyed a full complement of local, state, and national professionals known as supervisors in the 1960s and 1970s. Unfortunately, there has not been a person serving as supervisor for technology education in the United States Department of Education since the mid-1980s. At the state level, almost every state in the early 1970s employed a supervisor whose duties were dedicated totally to the supervision of technology education. Today the number of state supervisors has dwindled significantly, with many supervisors being assigned major job responsibilities in addition to those associated just with technology education. The same general pattern exists at county, district, and city supervisory levels. It is at these levels that technology education supervision may have its greatest impact.

Technology education supervisors have historically been recognized in many states and local education agencies as the key decision-makers, primary change agents, guardians of the budgets, inservice planners, and curriculum initiators. They are our primary leaders and administrators who serve as a valuable resource for technology classroom teachers and teacher educators, as well as undergraduate students preparing to be teachers. In recent years a growing and somewhat disturbing trend has been developing whereby technology education supervisory positions are awarded to individuals who have no formal education or background experience in technology education.

Collectively, these trends in technology education—a reduction in the number of supervisors at all levels, a broadening of job responsibilities, and a lack of background experience and formal education—must surely raise serious concerns among individuals in our profession. The decline of this precious human resource is alarming. Regardless of whether it may be politics or motivation undergirding the trends, it is abundantly clear that "doing more with less" is much more than a mere slogan or book title. All signals indicate that the condition of technology education supervision in this country will continue to create some very serious challenges. If the profession chooses not to address them, is it possible that technology education supervisors will become an endangered species?

There is no one simple solution to the problem. Many questions need to be addressed that may ultimately result in multiple solutions. What will happen to our profession if these trends continue into the 21st century? Should some group or organization in our profession be held responsible for the trends that have already developed? Who will perform the duties of the supervisor in those states and local education agencies that have no supervisors? Should technology education teachers become proactive by assuming responsibilities that were historically provided by their supervisors? What will be the impact on teacher training programs if such duties are to be performed by teachers? What will be the professional development needs of the profession if positions continue to be eliminated or awarded to individuals who possess no technology education background or experience? Ultimately, can anything really be done to change the course of what is happening? Here is what I believe needs to be done!

The first and most important step is for the technology education profession to address in a very serious way how to reverse these trends. It deserves our immediate attention. Although the profession must exert major influence, it is doubtful an immediate reversal will be realized given the present culture of public education. Public education has approximately a 200-year history of establishing what is widely recognized as the academic core in schools. Core subjects are viewed as essential and important and receive great public support. Subject areas outside the core are often considered less essential and less important. Many times noncore subjects' educators must justify their mere existence while being compromised with low budgets and less overall program support. Although technology education is viewed by our profession as an essential and important core subject, unfortunately, the larger education community has not yet embraced that viewpoint. Is it possible the public's perception of technology education is inextricably linked to the current status and quality of its supervision? Is it not true that core subjects typically enjoy qualified supervisory support?

Another important topic that deserves attention is to consider the merits of technology education supervisors who have no background education or prior experience in technology education. While they may be limited in the breadth and depth of services they can provide, they can perform important general oversight and public relations functions. On another front, there is some movement towards merging or integrating complimentary disciplines, for example, math, science, and technology education. Where these few bold and creative efforts exist, it may be satisfactory for a supervisor overseeing such an effort to have a background in only one of these areas. Safeguards must be present to ensure that program favoritism does not exist and that program status is applied equitably. I hope not to sound as if I am "protecting my own" as I sincerely believe that our programs are best supervised and administered by individuals who have backgrounds well founded in technology education. It has been said, "There's no substitute for experience." Individuals who have no teaching experience in technology education are at a distinct disadvantage when compared to people who have experience. Possessing the necessary background, philosophy, knowledge, and experience in technology education would seem requisite for proper advocacy, insights, and defense of the curriculum, budgets, in-service needs of teachers, and program monitoring.

Closely associated with the trends is the issue of job titles for supervisors. Titles are descriptors of one's supervisory duties and responsibilities. For example, titles may include director, supervisor, coordinator, curriculum specialist, teacher resource, training specialist, curriculum/program leader, and department head. Although one may question the merit of examining titles, there is typically a hierarchy of titles or at least a perceived hierarchy. The "pecking order" has significant implications for staff supervision, budget management, and other important functions that can help move a program forward. Many times a lower level title is assigned to a supervisory position so as to cause a lower pay rate, with less programmatic authority, yet requiring many of the functions (usually compliance and other paper requirements) performed by a typical supervisor. The requirements and expectations of these positions are further complicated if teaching responsibilities are an integral part.

Are technology education supervisors an endangered species lurking on the horizon? They will be unless the profession begins to immediately address the realities of public school culture and their impact on supervisory positions in non-core subjects. Current trends in technology education supervisory positions must be carefully and delicately balanced with the realities of what is occurring in education today. The profession must become more proactive and move into the mainstream of public education. Our leaders must help us identify alternative thoughts and approaches. Historically, when our profession was faced with a crisis, we looked to the leadership in higher education for answers. Unfortunately, that approach is no longer viable. During the past 10 years, higher education personnel and programs have been under great pressure as leaders and programs have decreased in number. In fact, the number of individuals entering the technology education profession at the higher education level is at a critical stage resulting in fewer faculty and fewer leaders.

Should our profession expect higher education faculty to train people who possess supervisory skills needed for the 21st century? I posed this question to several colleagues at institutions of higher education that have technology teacher training programs. Without hesitation, they indicated that higher education faculty must assume a more proactive role. But what is the best delivery program for the development of the requisite skills—pre-service or in-service? At the pre-service level, teacher education programs must include course work in the development of specific supervisory skills such as budget management and peer evaluation. Technology classroom teachers and department heads already need in-service training on a continuing basis in areas such as scheduling and marketing. In addition, people who have oversight for technology education but do not have formal education and background experience in technology education also need in-service training in areas such as program monitoring and conducting needs assessment. The profession needs to respond to this critical need at once. It needs to reconsider the type of professional development activities it provides current teachers while realizing that a new landscape of in-service activities will be needed for the 21st century. In-service programs that result in the development of supervisory skills must be an important segment in this landscape.

How to do more with less is a great challenge that deserves the full attention and commitment of all people in the profession. We may find some assistance through the use of the electronic world as it offers many choices that were previously unknown. The electronic world, however, is not a panacea for all supervisory activities. Supervisors often spend considerable time processing through local issues, local politics, local budgets, local management styles, and local personalities. These topics are simply not easily resolved or addressed via the electronic world. Face-to-face contact, continuous dialogue, and meaningful negotiation are often required.

People who have a lengthy tenure in the education profession have witnessed many pendulum swings in the way public education is managed. It is my opinion that the current status of supervision in technology education is on the back swing of the pendulum. Alternative methods to shore up supervisory responsibilities will continue to be tried and, in some cases, accepted. However, our 21st century agenda must include the reinstatement of a full compliment of national, state, and local supervisors who are equipped with specific supervisory skills. These key decision-makers, primary change agents, guardians of the budgets, in-service planners, and curriculum initiators must not become an endangered species. The fate of our programs rests with the presence of professional supervisors who possess formal education and background experience in technology education.

Now that you have read my essay, what do you think needs to be done? Should the profession allow our supervisors to become an endangered species? If you were a key decision-maker in education today, what would you do to raise the awareness level of the need for technology education supervisors?

Essay 20

Self-Renewal: Appreciating Yesterday, Celebrating Today, Anticipating Tomorrow

M. James Bensen
Bemidji State University
Bemidji, Minnesota

Cay Kroeten received a standing ovation as she walked across the stage, the last of 850 baccalaureate and graduate degree candidates to be recognized at the commencement ceremony. She had walked across similar stages before in her quest to earn 14 certificates, diplomas, and associate degrees in such wide ranging fields as business, nursing, Ojibway language, computer repair, cosmetology, the arts, human services, and yes, even small engine maintenance. On this particular day, the crowd applauded enthusiastically in recognition of her outstanding new achievement—a Bachelor of Science degree.

Cay Kroeten continues to work as an elementary school classroom volunteer. Prior to commencing work on her new degree, she felt she would be a better volunteer if she earned a degree in elementary education. Cay initially enrolled in the program at the age of 75, attended evening classes and enrolled in extension courses, and completed her program at Bemidji State University in the spring of 1998. She then walked back into the world supremely equipped to tackle her next challenge. Cay Kroeten knows quite well the power of self-renewal. She worked a lifetime in the transportation industry and on the side, engaged in various formal education programs.

What compels Cay Kroeten to pursue her continuing thirst for knowledge and know-how? Why is it she exudes self-confidence and excitement about her future? What drives her to excel, to give to others, and to live such an enthusiastic life? I do not purport to have all the answers to these questions but I do have some thoughts to share with you. It is obvious that Cay Kroeten is in continual self-renewal. Individuals and organizations experience renewal but it doesn't just happen either by chance or wishful thinking. Something special is necessary to bring about this phenomenon.

By its very nature, technology is constantly opening up new ways of doing things and thus driving change in our lives. It is all around us and it is pervasive in its ability to foster a different landscape every time we scan it. Technology education (the formal study of technology), by definition, is a field of self-renewal. We who work within this profession have a special obligation to engage in self-renewal as we build for a better tomorrow.

The perspectives of self-renewal are as many and varied as there are people involved with them. However, there are some key elements that appear as universals when we observe people who are outstanding examples of continuous self-renewal. The first self-renewal element is the ability to engage in visioning—a way at looking at the future and seeing opportunities dressed in disguise for people less fortunate. Looking at alternatives, conceptualizing problems as opportunities, and articulating them for others are a part of the visioning process. A second self-renewal element is to have an unwavering commitment to excellence, to never swerve from a personal quest to excel. Too often people accept second rate as good enough and thus their lives and workplace reflect this sad state of affairs. A commitment to excellence is a self-assignment of being personally responsible for nothing but the very best.

Another essential element of self-renewal is goal setting. Setting grand goals, which are lofty personal expectations that are always set just beyond our reach, is imperative to keep us on track in life. We must learn to record our goals and review them every six months, just to assess our progress towards reaching them. When we set individual goals or assist in setting goals for an organization, we must be open to change. Unless we are in constant search for improvement and follow our clearly articulated goals, we are in serious danger of becoming obsolete. This openness to change is always fueled by never being satisfied with the status quo.

Continuous learning is the one way to stay on the path to achieve excellence. It involves both formal and informal learning and can result in both increased credentials as well as newly honed expertise. Continuous learning also includes gaining knowledge and know-how that comes from firsthand involvement in research, design, and development. This puts the individual and the organization in a position to contribute to the knowledge of the field while at the same time learning from it.

A critical element of self-renewal is the ability to choose pursuits of personal interest. A person who has the benefit of doing what they love to do has a distinct advantage over people who hate their work or wait for small snippets of time to do what they always look forward to doing. Choosing pursuits of interest virtually self-propels people to be filled with the zest of the moment and the prospects of the future.

One must also be willing to take reasonable risks to fully participate in self-renewal. Risk taking is not a natural process for many people and it may be an aversion to others. Hence, to be able to step into situations where one has not been before, to deal with ambiguity, to design a preferred future, or to strike when the iron is hot even if the odds don't always give an indication that success is assured, will never be easy. However, if one has the confidence to follow their personal quest, to set lofty goals, and to put all their energy into pursuing their dreams, the element of risk taking is not as daunting as it might first appear.

Lastly, self-renewal is cemented in the thirst to serve others. It seems that much of life is filled with people who are either "givers" or "takers." When fully engaged, givers generate satisfaction, good will, and a better world for all. Conversely, when taken to extreme, takers never seem to get enough, achieve happiness, or contribute to the general good. Serving others is a powerful emotional high that can make a major difference in both a person's and an organization's self-renewal.

As this essay commenced, Cay Kroeten's life was illustrated as a prime example of individual self-renewal. As technology educators, each one of us must commit ourselves to individual self-renewal. It is a responsibility to us as individuals as well as to the profession to increase our personal capabilities, expand our horizons, and contribute to the well being of the field.

As individuals, each one of us can make a significant difference in our profession. Collectively, however, we can leverage the talent of the profession to reach heights that are beyond our imagination. In the private sector, the 3M Company is an excellent example of a company organized for self-renewal. This is a company that has over 65,000 products and comes out with 400 new products each year. They even make money on their mistakes, "if the glue won't stick, just sell it as post-it notes." The 3M company is a company dedicated to self-renewal. A goal expressed by one of their managers is that "30% of their revenues each year would come from technology developed in the last year. . . . in theory, then, in five years everything that they will be doing will be different than what they are doing today." That doesn't actually happen, but it does provide a virtual self-propelling environment of innovators.

As a profession of educators, we must ask ourselves how we can best learn from organizations that exude renewal. Just as the 3M company generates new ideas that seem to literally flow into the market, we as professionals in technology education must open ourselves to ideas and satisfy our thirst for acquiring know-how. Knowledge empowers people; the courage to act on that knowledge brings realization to empowerment. The future of our world lies in our ability to both individually and collectively act with realism, foresight, and the common good. This is not a dream—this is our responsibility. I hope you agree with me that self-renewal demands serious attention on technology education's 21st century agenda.

Essay 21

Blurring the Boundaries

Rodney L. Custer
Illinois State University
Normal, Illinois

"The smartest person I ever met has spent his entire life working as a mechanic in a Harley Davidson dealership!" The source of the observation was at least as striking as the comment itself. It came from someone uniquely positioned to know something about intellectual ability and the nature of education. His career has been spent as a faculty member and chairperson in a college of education at a large research university, working with bright and dedicated faculty, and mentoring talented graduate students. Yet, this motorcycle mechanic stood out in his mind above the rest. While the comment probes the nature of intelligence, the more penetrating commentary may have to do with the nature of education. What does it mean when brilliance somehow emerges apart from, and maybe even in spite of, a relatively modest formal education?

The hard reality is that schooling tends to work best for those who do well in individual academic disciplines, especially mathematics, language arts, and science. Students who succeed are those who can handle structure and spend at least a modest amount of time on homework. They tend to be good with facts and have become adept at taking tests. We must ask, "What can be done to improve education for more students and what can technology education do to help?"

Educational delivery systems tend to artificially carve schooling up into academic disciplines, separated from authentic contexts. While integration, authentic learning, and contextualized education have become popular in recent years, the reality is that little progress has been made in integrating the curriculum. This situation prompted Rustum Roy, a leader in STS circles, to observe that "we call it a Uni-versity. Nothing could be further from the truth!" At a time when technology educators are working hard to position the field as a new academic discipline, the question must be asked, "Do schools need yet one more academic discipline?" or "Would students be better served if technology education was to serve as the mechanism and catalyst for blurring the boundaries among the disciplines?"

Some powerful forces are at work within our culture that argue for a more integrated approach to learning. One of the most important of these has to do with the flow of information. At the turn of the last century, the challenge was to increase the flow of information, particularly into isolated rural areas. The development of the Rural Electrification Associations, the development of telephone and television networks, and the proliferation of transportation systems greatly enhanced the flow of information. Now, at the turn of 21st century, the situation is quite the reverse. We are increasingly being overwhelmed with information. The need has shifted from learning how to access information, to critically analyzing the worth of an onslaught of information. More important, the development of the Internet has expanded access to specialized information. The lay public can access everything from specialized medical information to detailed weather satellite graphics. With this increase in access to specialized information, the value of disciplinary structures becomes less important. While we need to help students probe areas of interest (go deep), we also need to help them connect different kinds of information (go wide). Enabling students to access and connect information is more important than concerns about which discipline owns the content.

A second voice promoting integration across disciplines comes from employers. Reports such as SCANS and Workforce 2000 indicate a high demand for people who can think critically, solve problems, and interact appropriately with people. These activities require an ability to access and connect information from a variety of sources in order to arrive at solutions to real world problems. Factual knowledge is needed; but it is of little value in the absence of an ability to make connections.

Globalization has also pressed the need for interdisciplinary learning. People are being exposed to one another's cultures. Political and social inequities are being exposed into full public view, which is forcing many people to think in some unfamiliar ways. This kind of open, cross-cultural exchange of views and information demands an ability to connect diverse kinds of information and perspectives. Drawing boundaries around knowledge is out of step in an era of open exchange of cultures, views, and perspectives. We need more connections and fewer walls.

A final voice being sounded in the schools is for relevance and real world applications. Students and parents want education to occur in real world contexts. A related problem is that we tend to overestimate the ability of students to transfer knowledge across contexts. We must find ways to stimulate active inquiry with the kinds of real situations that students face.

Given this broad context, we should have little patience for schools structured according to disciplines, facts, and outdated political alliances. We need to find new ways of doing school.

What can technology education do to help? How can we make schools better places for learners in the 21^{st} century? What can be done to blur the boundaries and make schooling more relevant for a majority of students? I recommend the following as food for thought.

If technology education is to effectively serve as an integrator, we must increase our breadth and depth of content knowledge. If we are going to convincingly approach core academic disciplines with proposals to integrate, we must possess a solid knowledge of what we are talking about. We must bring something to the plate. For example, to claim to use technology education to integrate language arts, mathematics, and the social sciences without a basic understanding of the issues and content of those areas leaves us with an enormous credibility gap. Integration will force most technology educators to extend their range of knowledge beyond what they know today.

Technology education must continue to address issues of image and recognition. We have a great deal to learn about how to market the profession. Sustained effort will be needed to convince the academic community that we are creative, well-informed, and knowledgeable educational professionals who are extremely effective at helping students learn in authentic and connected ways. We also need to target our message to attract a broader and more diverse spectrum of the population, particularly women and minorities. The technology education standards will help, as will the resulting curriculum development and teacher in-service. But, nothing communicates better than the power of exciting and working examples. The public needs to see our best practices—those wonderful pockets of brilliance that are sprinkled across the nation in technology education classrooms and laboratories.

We need to become comfortable with sharing the load of teaching technology education with other academic disciplines. This may even mean thoughtfully reconsidering the notion that technology education should be yet another academic discipline. An already crowded academic curriculum coupled with the powerful forces seeking to maintain current turf boundaries, pose serious barriers to adding another discipline. A positive alternative would be to align with those who realize that meaningful learning requires context and connections. We must find ways of helping teachers and the public understand that the best learning happens when teachers from various academic areas pool their resources and connect their content in ways that are meaningful and authentic for their students.

Technology educators should build relationships with educators from other academic areas by participating in their conferences and professional organizations. Similarly, other educators should participate in conferences and organizations of technology education. Unless and until all educators have invested time, resources, and energy, meaningful integration will be unlikely. These other academic areas are represented by such organizations as NCTM, NSTA, the social science organizations, AERA, and ASEE.

To spark these needed changes, the profession must become more adept with educational and political policy. Specifically, we need to connect effectively with state and federal departments of education and funding agencies (e.g., the National Science Foundation, the Sloan Foundation, and NASA). People within our ranks need to be well connected with publishers and curriculum developers. We need to be at the table when others are developing and assessing standards and curriculum initiatives. We must be involved across the spectrum of political policymaking activity at the local, state, and national levels.

We need to help employers gain access to the academic world. What kinds of skills and abilities do they value? What would they like for us to be teaching in the schools? This is a daunting challenge since appropriate boundaries should be maintained between the academic and the work world. Schools should extend beyond vocationalism and the demands of the workplace. Nevertheless, education in the absence of authentic experience erodes into irrelevance. Teaching students to think is insufficient. They must also learn how to think critically about real world situations. Technology related issues (e.g., cloning, environmentalism, food production, aging, population control, and space travel) will almost certainly be critically important contextual elements in the 21st century.

Finally, we should challenge deans and other leaders in colleges of education to think through how to do integration. State standards development efforts across the nation are exploring ways of breaking down disciplinary barriers as they explore essential elements that should comprise the basic education of all students. Colleges of education are looking for new models and ways of structuring and, too often, have gone wanting. Innovative practices must be developed, tested, and submitted to the rigors of research.

If the technology education profession is successful with an integration agenda, we could well find ourselves at the core of education in the 21st century. But integrated learning environments will be very different. The risks and demands will be considerable. The integration of academic content threatens turf, triggers insecurity, and raises concerns about whether students are really learning the content. Technology educators will need to be schooled and reschooled in such things as facilitating change and understanding the integration process. Most of us will be challenged to broaden our range of knowledge in order to legitimately and meaningfully work with environmentalists, scientists, theologians, social scientists, and more. The ramifications for technology teacher education are serious. If successful, we will spawn a new vision of education where learning really does transcend disciplines and, to some extent, even schooling. Perhaps we can look forward to schools where it just isn't all that relevant whether students are doing mathematics, language arts, science, or technology. What if it turned out that technology educators were the ones who sparked the change and led the charge?

Essay 22

Standards-Based Reform for Technology Education

William E. Dugger, Jr.
Technology for All Americans
Blacksburg, Virginia

In 1983, the National Commission on Excellence in Education published a report titled *A Nation at Risk*. The report stated that other countries' schools were doing better than ours were in quality and equality of learning. This influential report planted a seed of unrest and set the stage for standards-based reform as a means for improving our educational system.

"Starting school reform by first identifying what every child should learn strikes most people as only common sense" (Gagnon, 1995, p. 65). As past director of the Fund for the Improvement and Reform of Teaching for the U.S. Department of Education, Gagnon used these words to describe the integral role of content standards in educational reform.

Americans have been calling for high, common standards for more than a decade. Developing these standards is a tricky and complex undertaking requiring change—sometimes revolutionary change. Leaders in education, business, and the community have accepted this challenge and they are now in the formative stages of producing quality content standards. As a result of their leadership and commitment to this process, many historians may view standards-based reform as one of the most important periods in educational reform in this country in the past century.

In the late 1980s and early 1990s, numerous school disciplines and fields of study began developing standards for what each student should know and be able to do in their content area in order to be literate. Mathematics was the first field of study to develop national standards. The National Council of Teachers of Mathematics (NCTM) released the *Curriculum and Evaluation Standards for School Mathematics* in 1989. In the 1990s, geography, language arts, history, economics, and other subject areas developed content standards. In science, two different sets of standards were generated; the American Association for the Advancement for Science as Literacy produced *Project 2061 Benchmarks for Science* (1993) and the National Research Council released *National Science Education Standards* (1996). More than 15 sets of educational standards have been developed at the national level, including standards for technology education.

A flood of reform movements swept the field before technology education developed content standards. This reform stemmed from dissatisfaction with industry as the major content organizer, a result of the field's origin in industrial arts. Over the past 50 years, the study of technology has gained prominence as the new paradigm for technology education. As Neil Postman stated in *The End of Education* (1995), technology education should be taught to every student in school today as an essential, required subject.

Another result of the reform movement was the publication by the Technology for All Americans project titled *Technology for All Americans: A Rationale and Structure for the Study of Technology* (1996). This document outlines the universals for the study of technology and creates a refined framework for the study of technology. Knowledge, process, and contextual bases are identified within the universals. Under the universals, more specific categories called dimensions are identified. These include processes and knowledge, such as the History and Evolution of Technology, Designing and Developing Technological Systems, Determining and Controlling the Behavior of Technological Systems, Utilizing Technological Systems, Assessing the Impact and Consequences of Technological Systems, and Linkages. The unifying contexts include Informational Systems, Physical Systems, and Biological Systems.

With a framework in place, technology education joined other fields of study in developing national content standards. *Standards for Technology Education: Content for the Study of Technology* (Technology for All Americans, 2000) provides the basis for what every child should know and be able to do in order to be technologically literate. The universals and dimensions identified in the Technology for All Americans (1996) project's rationale and structure document, with a slight refinement of the wording, provide the basic structure for the content standards. The content standards are organized by grade levels (K-2, 3-5, 6-8, and 9-12) and present an articulated curriculum that increases in rigor from kindergarten through grade 12.

The standards provide a means to enhance the common core of learning for all students in a form that every teacher can implement. They also are developmentally appropriate for each student in grades K-12 and establish qualitative and quantitative expectations of achievement for all students. Importantly, standards provide lifelong learning, maturation, and career enhancement opportunities in technologically oriented professions, such as engineering, computer science, biotechnology, and architecture.

There are many things that the content standards are not. They are not a federal policy or mandate. They are not a curriculum, which describes how and when the content prescribed in the standards is delivered in the laboratory or classroom. The content standards are not a panacea to all of the problems in education. However, they are voluntary in nature; therefore, the curricular decisions for using them reside at the state and local levels. A united effort of many diverse groups and individuals is required in order to ensure that the content standards continue to be successfully implemented.

The release of the content standards marked only the beginning of the standards-based reform movement in technology education. Curriculum developers, along with textbook publishers and laboratory developers, for example, are the initial users of the content standards. Many states and localities that currently do not have technology education standards are adopting the content standards for their use. In those states that already have standards for technology education, they are reviewing the content standards and then adapting or infusing them into their standards.

The organizational structure of each state or locality determines who is carrying out the curriculum work. In states with technology education supervisors, these individuals are working with local supervisors and teachers in writing an articulated, planned curriculum at each grade level, from grades K-12. In states where a state supervisor for technology education does not exist, then local schoolteachers and administrators are taking the responsibility of developing a curriculum framework.

The difficult job of articulating the subject matter across all the grades requires equal collaboration of teachers at all grade levels—elementary, middle/junior, and high school. Ultimately, teachers use and implement the content standards. This is true whether their schools have state-developed standards, local standards, or even if they do not have any standards. The final success or failure in the use of the content standards rests with the teachers, who are an integral part of the standards-based reform movement. In those areas that have successfully implemented the content standards, teachers are given not only the responsibility of developing the curriculum, but also the authority to make choices and decisions that are most important to their students and to them as teachers.

Teacher educators also should have firsthand knowledge of the content standards in order to provide the best pre-service programs to prepare future technology teachers. Other users of the content standards include administrators, such as superintendents, directors of instruction, supervisors of technology education, parents, and principals.

In addition to developing curriculum based on the content standards, there is a need for developing student assessment standards, program standards, and professional development standards (in-service and pre-service) at the national, state, and local levels in technology education. Also, there is an acute need for developing a cadre of teachers, curriculum developers, teacher educators, and administrators who can effectively lead educational reform and implementation in technology education.

The infrastructure, or physical environment, for teaching technology education must be appropriate and up-to-date. This includes such aspects as facilities, equipment, and materials. In addition, the safety and health of the student must be of utmost concern in the learning environment. Instructional materials, resources, and textbooks must be current to reflect the content standards. The criteria for judging the quality of the textbook are to compare its content to the content of the standards.

School administrators, including superintendents, directors of instruction, curriculum developers, and principals, need to support technology education as an essential field of study. They must be convinced and be able to defend the need for technological literacy for all students. Likewise, they should provide the support and funding for the teaching of technology education. Current staff must participate in professional development activities and in-service programs that will help them to implement the content standards.

There are numerous obstacles and pitfalls to standards-based reform. Probably the most popular is the "If it ain't broke, then why fix it?" attitude of many educators. As humans, we are resistant to change because it is more comfortable to do things the way we have been taught. The power to overcome this mentality lies in one's commitment to objectively become familiar with the content standards and to learn about them in-depth. Next, the curriculum must be analyzed to see how it can be changed to reflect the content standards.

Another reason for not accepting standards-based reform is that teachers are ill prepared to implement the standards. To surmount this obstacle, teachers must actively participate in curriculum revision based on the content standards so that they will buy into the changes and take ownership of their curriculum. Every teacher needs professional development training that will educate them about the standards, as well as how to implement them.

The power of the content standards is that for the first time the technology education profession has identified what all students should know and be able to do in order to be technologically literate. The endearing promise of the content standards lies in their capacity to change fundamental components of the educational system.

Standards-based reform is a permanent part of educational reform. In an article in *Education Week,* Christopher T. Cross, president of the Council for Basic Education, stated, "I am often asked in forums across the country whether standards are here to stay or simply a passing fad that will soon be replaced by another fad. My answer remains firm and consistent: Standards are here to stay. The effort has survived almost a decade of attempts to sabotage it and, in fact, public support is stronger than ever" (1998, p. 35).

The content standards represent not an end, but a beginning. In many cases, developing standards has been the easiest part of this vision for reform in technology education. The difficulty lies ahead in the acceptance and implementation of the standards in grades K-12 in every school. This is a starting point for action within local schools and districts, as well as states, so that technology becomes an essential field of study for all students. The common sense of educational reform and the improvement of technological literacy begin with the implementation of these standards—now, at the beginning of the 21st century.

REFERENCES

American Association for the Advancement of Science, Project 2061. (1993). *Benchmarks for science literacy.* New York: Oxford University Press.

Cross, C. T. (1998, October 21). The standards wars: Some lessons learned. *Education Week,* 32-35.

Gagnon, P. (1995, December). What children should learn. *The Atlantic Monthly.* 65-68, 70-78.

National Commission on Excellence in Education. (1983). *A nation at risk.* Washington, DC: United States Department of Education.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Research Council. (1996). *National science education standards.* Washington, DC: National Academy Press.

Postman, N. (1995). *The end of education.* New York: Alfred A. Knopf.

Technology for All Americans. (2000). *Standards for technology education: Content for the study of technology.* Reston, VA: International Technology Education Association.

Technology for All Americans. (1996). *Technology for all Americans: A rationale and structure for the study of technology.* Reston, VA: International Technology Education Association.

Essay 23

Teachers for Tomorrow

William D. Greer
Fort Worth ISD
Fort Worth, Texas

A student enters the classroom, sits down at a computer, puts on Sega Virtual Reality glasses and a Mattel PowerGlove, grasps a Gravis joystick, and begins to explore the inner workings of a computer or begins to fly around the solar system. Truth, science fiction, or just a humorous perspective on the future? Can this possibly be happening in technology education today? If your answer is yes, are we preparing our teachers to function in this type of program?

During the 20th century, our society moved from the agriculture age to the industrial age; from a goods producing society to an information based society; and now we are a service and knowledge based global society. We know that the societal base will change twice during a student's K-12 education. How can our educational system even address the exponential growth in technology? What should be the specific role of technology education in the process?

We live in a data driven society and some of the data indicate that 50% to 60% of the students entering the labor market in the year 2000 will be employed in jobs that did not even exist when they began school (Witter, 1998). These same students will make major career changes (not jobs) five to seven times during their working adult life. Data also indicate that 5% of the jobs in the year 2000 will require less than a high school diploma, 20% will necessitate a baccalaureate or advanced degree, and 75% will require technical training or an associates degree. Data identify real problems but now more than ever, we need real solutions. What will be expected of our teachers for tomorrow?

I will address the problems from three perspectives—the classroom setting, instruction, and pedagogy. The development and production of the personal computer are having a dramatic impact on the classroom setting. It is common today to find computers on the desks of most teachers, and computers are readily available to students. The rise in popularity of modular based technology education laboratories has fueled the need for personal computers in our programs. Currently, some of these laboratories are networked and some stand alone, but few are connected to systems outside the classroom.

I predict that technology education classrooms in the 21st century will look substantially different from those of today. They will resemble a research facility with a transparent window to the world. If we expect students to compete successfully in a global society, they must have rapid access to the knowledge base of that society. The stand-alone classroom will become as obsolete as the stand-alone computer. Students and parents will expect the educational community to provide equipment that can easily access local and area wide networks as well as the World Wide Web.

Savage (1998) identified some core technologies that will be shaping the classroom in the 21st century: (a) optical data storage devices including advanced compact disks, bar code readers and 3-D holographic crystals; (b) advanced computers such as electronic notepads, multimedia computers, telecomputers, parallel processing computers and multisensory robotics; and (c) distributed computing incorporating electronic data interchange and desktop videoconferencing. In addition to the core technologies, Savage (1998) identified other technological advances that will have a significant impact: (a) fiber optics for telecommunication systems, distributed computing systems, endoscopic technology and virtual retinal displays; (b) advanced satellites with low earth orbiting and direct broadcast satellites; (c) high-tech ceramics for abrasives, heat shields, ball bearings, engine components and artificial bone implants; and (d) fiber-reinforced composites. In order to function in this type of environment, technology education teachers must address the *what* and *how* of teaching. For example, the physical change of the classroom and its equipment will foster a significant change in instruction.

Students in the 21st century will be better prepared technologically than students in past centuries. Kindergarten and first grade students will already be using computers to complete elementary level technology activities including research, desktop publishing, simulation, and animation. At various levels of proficiency, students will have been exposed to or possess an in-depth knowledge of computers, telecommunications, desktop publishing, animation, and many other applications of technology well before they begin secondary education. The curriculum will need to be continually updated in recognition of the advanced knowledge and skill students will bring to the classroom.

Today, the World Wide Web is an essential element in obtaining and transmitting knowledge. This resource will become even more invaluable in the future to students and teachers. The exponential growth of technology will mandate that teachers use the knowledge and resources of business and industry, fellow teachers, and the world community in order to enhance their programs. Students will complete assignments in conjunction with students from other cities, states, and countries.

Technology education teachers will need to be self-motivated, flexible, and enjoy working with a diverse group of students. They must also be problem solvers, critical thinkers, and technologically literate. Teachers in the early part of the 21st century must bring to the classroom well developed skills in dispute resolution, motivation, and conflict management in order to cope with the special needs of diverse populations.

Individuals from varied backgrounds or from under-represented gender and ethnic groups will be highly recruited to become teachers. As the demographics of the nation shift, it will be imperative that the brightest of these individuals be encouraged to enter the teaching profession, particularly technology education.

In the 3rd millennium, teachers will be called upon to teach more than just content—they will facilitate the total teaching and learning process. While the move from teacher to facilitator is not a big step, sometimes it can be a difficult one. The facilitator must be able to cope with a variety of learning activities taking place concurrently. Technology education teachers will be expected to integrate learning activities that provide students opportunities to use knowledge learned and skills developed in other classes such as mathematics, science, and language arts. In a large part, these activities will be based in a true problem solving setting. Maintaining a student-centered environment in an experience-based instructional program that includes input from many sources will be a fundamental requirement of the facilitator. The facilitator will have a strong working knowledge of a variety of assessment methods including portfolios, project development, tests and measurement, and documentation procedures. An understanding of the cognitive, affective, and psychomotor domains and the ability to apply them in a variety of settings will be important. Additionally, a facilitator must understand multiple intelligences such as verbal, mathematical, body, and spatial (Gardner, 1993).

Teachers must be able to communicate effectively in a variety of medias and contexts in order to transmit relevant information, promote their programs, and become an integral part of the education process. Written and oral communication skills will be important and the ability to incorporate all types of communication using many forms of technology will be essential. Teachers will communicate with other teachers, students, administrators, parents, and the community as part of their daily routine. Where will we find the people that I have just described? Who will train them? These questions pose some of the greatest challenges facing the technology education profession today.

As I view pedagogy for the 21st century, I predict it will be in a constant state of change. Technology will drive the curriculum but curricular decisions will drive the purchase of technology for our programs. Curriculum documents will be in a constant state of flux while reflecting many of the new and innovative programs for students. The emphasis will be on learning outcomes rather than skill specific results.

The Secretary's Commission on Achieving Necessary Skills (SCANS) report (1991) and its supporting documents provide a clear picture on what is expected as we draw closure on the 20th century. Many of the skills identified by SCANS will be required in the 21st century. Specifically, these skills include the Foundation Skills of Basic Skills, Thinking Skills, and Personal Qualities as well as the SCANS Competencies of Resources, Information, Interpersonal, Systems, and Technology.

Curriculum will need to be developed to prepare students for a world in which workers are empowered in decision making processes and who are working in self-directed and self-motivated positions. Students will be required to know a variety of technologies and to use those technologies to complete activities. The concept of life-long learning will be incorporated into the curriculum. The question of whom will set the framework of the curriculum in the future needs to be answered. Will it be national standards, state standards, or even local education agencies? Will standards be voluntary or mandatory? Will there be models for teachers to follow? What will be the role of universities, businesses, industries, technical schools, and state agencies in developing research and curriculum documents?

The classroom instructional program will no longer be the domain of just the technology education teacher. It will be the result of a consensus building process involving teachers, parents, students, and the community. The program will be driven by an ever-changing technology. The future is exciting and challenging for tomorrow's teachers. It might be stated that the word tomorrow will be the byword of our teachers, for as tomorrow changes, so will all of their future tomorrows. The one constant in their professional and personal lives will be change, and this will be even truer for the future of the students with whom they have been charged.

P.S. If you want to see the classroom described in my opening paragraph, visit Kelly Walsh High School in Casper, Wyoming. They have had the program since 1993.

REFERENCES

Booth, S. A., Ronge, L. J., & Vizard, F. (1996, September). VR in the Classroom, *Popular Science, 249*(3), 62.

Gardner H. (1993). *Multiple intelligences: The theory in practice.* New York: Basic Books.

Savage, E. (1998). *Some thoughts on technology education year 2000 and beyond.* Paper presented at the Technology Education Professional Improvement Conference, Corpus Christi, TX.

The Secretary's Commission on Achieving Necessary Skills (1991, June). *What work requires of schools.* Washington, DC: United States Department of Labor.

Witter, B. (1998, July). *The truth about career decision making.* Paper presented at the Technology Education Professional Improvement Conference, Corpus Christi, TX.

Essay 24

The Age of Virtual Reality

Richard Grimsley
Texas Education Agency
Austin, Texas

The hatch banged shut behind Stone as he entered the capsule. He could hear people turning the compression handle to seal his chamber from the rest of the craft. He knew he should move quickly to the controls and make preparations for his craft to be jettisoned into the unknown. Yet, he also knew that he controlled many factors such as the length of his trip, his destination, and what he was going to explore when he got there.

Stone had stepped into a virtual reality simulation chamber located in his technology education class. Computers in chambers like the one in his class are configured to calculate how the real world will react when subjected to given situations. Supercomputers that control simulation chambers are capable of processing billions of instructions per second. The chambers are designed to mimic the real world and allow students to experience educational opportunities otherwise unavailable to them in high school. During this week in class, Stone has already visited a Nissan plant in Japan, a Nuclear Reactor in Texas, and today he is scheduled to explore the ecological system along the Great Barrier Reef off the coast of Australia.

Each trip the students take is preprogrammed into the Virtual Reality (VR) system. The computer is programmed to configure experts in each of the scenarios to guide the students through each virtual experience. The experts give students background information, guide them on the tours, and answer their specific questions about their virtual tours. A data recorder documents the entire experience and automatically sends the data to the students' network drive. At the end of each virtual trip, students are required to complete cross-disciplinary assignments in math, science, English, and social studies, which are related to each of their virtual trips. *The classroom discussion and assignments center on the virtual* reality tours. To complete the assignments, students have access to a team of teachers, engineers, and experts from business and industry who are available instantaneously via e-mail or in a web chat room to help guide them in their studies.

Is the aforementioned scenario fact, fiction, or virtual reality? We are well aware that the use of computers in technology education laboratories in the United States increased dramatically in the 1990s. For example, computers have been used in a broad range of applications from keyboarding to interfacing with other technologies. In addition, the computer is viewed differently by people throughout the world in the context of technology education. For example, some people view the computer as technology and others see it as a technological tool. Regardless of viewpoint, however, the computer is an awesome resource that technology educators are just beginning to tap.

Jaron Lanier coined the term "Virtual Reality" (VR) in the 1980s. VR is a way of referring to high speed computers, advanced programming techniques, and interactive devices that makes it seem as if the computer user has stepped into another world. Virtual is "being in essence or effect though not formally recognized or admitted" (Merriam-Webster, Inc., 1989, p. 1317) and reality is "a real event, entity, or state of being real" (p. 980). Pasted together, "Virtual Reality" is an event or entity that is real in effects but not in fact. The primary characteristic of VR is inclusion in the environment. VR places the participant inside the information. It is about illusion projected in the theater of your mind. As long as you can see the screen, you are not in VR. When the computer and screen disappear, you become the ghost in the machine and see the imaginary screen, and then you are in VR (Pimental & Teixeira, 1993). In a VR environment, the user no longer types commands into the computer, rather the computer responds to the user's movements in the VR environment. VR is a new medium for getting hands-on information, getting inside the information, and representing ideas in new ways. It is the first intellectual technology that permits the active use of the body in the search for knowledge. Since users become completely immersed in VR, they experience new forms of interaction—ones that may be as important to the future as film, theater, and literature have been to the past (Heim, 1993).

VR simulation is used in the aerospace industry. For example, pilots have trained in flight simulators for years. NASA uses it not only for pilot training but also for weather simulation and storm forecasting. Currently, VR research is being done in the areas of computer design, computer manufacturing, programming, and graphic design.

Virtual reality begins with a powerful computer that creates complex three-dimensional graphics. The unique feature, which sets VR apart from other complex three-dimensional computer view systems, is the fact that in VR you don't just view the graphics. In VR you become a part of the virtual world, surrounded by the images you are viewing and with which you are interacting. VR does not physically take the participant to the location they are viewing on the screen nor does it merge them with the world they are viewing on the computer. However, the graphics displayed by VR systems can be so realistic and the control tools so easy to manipulate that users often think they are in another environment. That is the goal of VR. This interaction is made possible by special equipment. In most VR systems, users wear special headgear such as goggles or helmets, which are known as head-mounted displays. The computer projects slightly different images for each eye creating the illusion of depth. Another key component of VR is sensors. These can range from a glove worn on the hand to the tracking systems used in the helmet. These sensors report to the computer any movement of the user. The computer then reacts to the movement by adjusting the images projected in the helmet. Other VR systems may have joysticks like those used in video games, treadmill devices that let you walk through the virtual world, and body suits that report body movements to the computer. Some systems add sound to the images so that as a user walks toward the images, the sound gets louder. There are even systems that go as far as incorporating olfactory devices that allow participants to use their sense of smell. Advanced systems allow several people to interact with each other in the same virtual world. All of the sensations of vision, sound, and touch feed into the brain at once and help create the sense of a three-dimensional reality.

VR is not the result of one individual working toward a single objective, but the independent work of many scientists, technicians, and designers. The development of several components of VR began in the early 1960s and has progressed slowly to where it is today. However, with the advances in computer technology, VR has the capacity to grow rapidly.

VR has quickly found its way into several fields because of the variety of influences that have led to its creation. As VR technologies advance, systems may someday be able to mimic the full range of textures, tastes, sights, sounds, and scents of the physical world. Today, business and industry are using VR because of its relative low cost, low risk to the user, and its ability to provide a variety of situations on demand. These same factors make VR an attractive alternative for the technology education classroom.

What does VR hold for the future of technology education? Here are some selected examples. VR will allow technology education students opportunities to explore a variety of experiences that are similar to those they may later encounter in business and industry, without the risks associated with these activities. VR will allow teachers to introduce concepts that were previously thought difficult for students to learn in a traditional classroom setting. In a construction course, for example, students will be able to experience the architectural wonders of the world through a historical perspective while gaining a firm understanding of the structural and mechanical components of each site. In-depth study of these sites will help students understand the advantages and disadvantages of each type of construction method and develop an understanding of how construction techniques have evolved around the world.

In energy, power, and transportation, students will be able to explore different modes of transportation ranging from small boats to racecars. Further exploration will reveal the advantages and disadvantages of each mode of transportation and the effects they have on the environment and society. Students can also explore how energy is produced, including alternative energy production that individuals have explored for centuries. Students will be able to study nuclear, coal, and hydroelectric powered plants to gain a real hands-on understanding of how each system works. After gaining a firsthand knowledge of how energy is produced, students can then explore the means used to convert energy into power. Students will be able to study not only the most advanced technologies available in producing power, but also the advanced methods of conversion.

In manufacturing, students will be able to visit plants around the world while studying different methods of manufacturing such as just-in-time, custom, and handmade techniques for a wide range of products from food to automobiles. This exploration of manufacturing in a variety of contexts will provide the opportunity for students to understand for the first time the importance and role of production in our society.

In bio-related technology, students can explore constraints and possibilities in the areas of ergonomics, waste management, food production, and medicine without physically going to the dangerous sites necessary to study many of these areas. For the first time in the history of technology education, students will be able to walk out of our classrooms truly technologically literate in a wide variety of areas, contexts, and applications if we embrace the use of VR. VR has the potential set the stage for a globally technologically literate student.

The possibilities created by VR for technology education are as encompassing or as limiting as the creativity of its users. With the identification of technological literacy by the Technology for All Americans project as a key component in a student's educational preparation, I predict that technology education will maintain its cutting edge status if VR is incorporated into its programs. Therefore, VR must be high on every technology educator's agenda in the 21st century. People who choose to ignore its importance are missing an opportunity to move their technology education programs forward into the new millennium.

REFERENCES

Heim, M. (1993). *The metaphysics of virtual reality.* Oxford: Oxford University Press.

Merriam-Webster, Inc. (1989). *Webster's ninth new collegiate dictionary.* Springfield, MA: Merriam-Webster.

Pimental, K. & Teixeira, K. (1993). *Virtual reality, through the new looking glass.* New York: Intel/Windcrest/McGraw Hill.

Essay 25

Envisioning The Whole Technologist

Patricia A. Hutchinson
The College of New Jersey
Trenton, New Jersey

MEN FLEW IN DREAMS AND COMMUNICATED INSTANTANEOUSLY IN MYTHS AND FAIRY STORIES LONG BEFORE THEY ACHIEVED THE TECHNICAL APPARATUS TO DO SO. BUT WOULD ANY CHAIN OF DISCOVERIES AND INVENTIONS HAVE PRODUCED A BALLOON OR A TELEGRAPH IF THE DREAM HAD NOT FIRST SUGGESTED THESE GOALS? (LEWIS MUMFORD, 1964, P. 22)

The history of technology is full of role models, but none is more universally admired than Leonardo da Vinci. Revered for the breadth of his interests and talents, Leonardo is the epitome of the Renaissance person. For technology educators, the lesson of Leonardo is that art—not science—is the key ingredient of invention.

Technology education has still not yet fully defined itself. Our leaders are urging us to strengthen our links with science, and to envision ourselves as a partner of that well-established and respected discipline. But science and technology are very different enterprises, with different ways of looking at the world. If we looked at Leonardo merely through the "glasses" of science, we would certainly miss some of the archetypal technologist's most important qualities.

All students need to learn certain communication and thinking skills to function successfully in the adult world. To achieve these skills, they study English and math, and since the 1960s, science, along with social studies and other subjects apparently not quite so critical, since they are rarely reflected on the benchmark tests. (During the height of the industrial age, earlier in the 20th century, it was also felt that knowledge of the activities and systems of industry was essential for helping boys take their place in contemporary society.)

The industrial age, the age when the manufacture of products required the labor of the majority of the population, is behind us. We have entered a new era, defined by the manipulation of information and characterized by opportunity limited only by lack of creativity—and poor resource management. The job of preparing young people for adulthood in this new era requires rethinking education.

The 21st century adult still needs to be a communicator and a clear thinker, but the impacts of changing technology have also made us look into our nature to discover what more is needed of a capable adult. What we've discovered is a dimension that might be called the designer-technologist. The designer-technologist exhibits the following characteristics:

1. Works to improve the human condition.
2. Possesses the technical know-how to solve practical problems.
3. Values both intuitive and logical modes of thinking.
4. Risks disapproval to introduce something new.
5. Appreciates the relationship of both hand and mind in developing ideas to fruition.
6. Derives satisfaction from creative activity.

Aspects of the designer-technologist are in all of us, but modem education has really never tried to foster individuals with all these qualities. In the industrial age, a purposely-stratified society required a small number of managers and a vast pool of laborers. The time may have come to consider the designer-technologist as a new vision of adulthood. So how do we incorporate these qualities into education? We look for role models.

Leonardo da Vinci may not embody all the human qualities needed for the 21st century, but his practicality, his creativity, and his refusal to be bound by disciplines speak to us across the ages. As technologists, we are drawn to Leonardo for several reasons:

1. We share his interest in the made world, his fascination with things that work.

2. We are amazed by his inventiveness, the sheer idea of an imagination so far ahead of its time.

3. We are charmed by his drawings, which transcend barriers of language and mirror writing, and show us whole concepts at a glance.

Perhaps Leonardo appeals to us because he is the pioneer and product of an era not so different from our own. The Renaissance was a time of dissolution of "the boundaries which had previously kept different intellectual traditions in water-tight compartments" (Randall, 1961, p. 129). Leonardo is an example of the kind of personality who could break through the boundaries. The Renaissance Man—someone with significant knowledge of just about everything—symbolizes the first, and also the last, of a kind. By bringing together quite different perspectives, Leonardo and his contemporaries foresaw and paved the way for political, scientific, and technological feats that have multiplied human knowledge far beyond the capability of anyone to ever again really claim the title of Renaissance Man or Woman.

Leonardo da Vinci was apprenticed to a Milanese artisan, the painter Verrochio, at about age 14. From our point of view, Leonardo studied art, but the definition and training of an artist in the 15th century were considerably different from today. There is evidence that Verrochio's studio carried out not only painting commissions, but also produced and repaired metalwork products such as jewelry and tableware. Like his fellow apprentices, Leonardo would have done everything around the painter's studio, from cleanup and general maintenance to learning the mathematics of scaling and perspective in monumental paintings, and the technology of mixing pigments, building scaffolding, erecting kilns, and forging and casting metals. His workshop may also have repaired such mechanical objects as hand tools and clocks.

To perfect his craft, Leonardo would also have done a great deal of drawing, first copying the works of old masters, then drawing from plaster casts, and finally from life. Drawing assignments would have been carried out, then critiqued and improved and further critiqued in a reciprocal process of making and judging. Leonardo's training in drawing prepared him to be an observer in minute detail of the physical world. It also gave him records of times and places, weather and circumstances, natural and built objects, and personalities and relationships to which he could refer in creating whole new scenarios. Thus, Leonardo could be both "a recorder of actual worlds and a creator of imagined ones" (Turner, 1993, p. 158). Here, then, is a clue about the education of the designer-technologist. Today's research on creativity bears out the need to experience and notice much in the world and to be able to organize and access what has been observed.

Leonardo's talents, while rare, are probably not unique. He was fortunate to be born at a time when the medieval vision of learning as religious insight was giving way to an appreciation of knowledge as a means to power and practical progress. In breaching the boundaries, Leonardo "worked toward a total integration of philosophy, art and technics" (Interview with Paolo Galluzzi in Pearson, 1997, p. 53) to create a new commodity—technological creativity—for which he found sponsors and patrons with practical projects to challenge his inventive talents.

Modern scientists appreciate Leonardo, but not as a scientist. Leonardo was "an artist, every sort of artist—a painter, an engineer, a canal-builder, an architect, an inventor and all the rest" (Randall, 1961, p. 123). His drawings for inventions exemplify the process of an artist, whose "interest in the particular and concrete inspires his careful, precise and accurate observations" (p. 123). Historians of science further note that all of Leonardo's theoretical observations were known by scientists of his day, and that, even if he had made a unique discovery, it would have exerted no influence on the progress of the field of science, since Leonardo made no attempt to publish his work.

Erwin Panofsky, in the publication *The School of Padua and the Emergence of Modern Science* (Randall, 1961), makes the following observation about Leonardo's methods and underscores the connection between science and technology. He stated, "The invention of a method of recording observations through revealing drawings . . . deserves to rank with the invention of the telescope and the microscope in the seventeenth century and of the camera in the nineteenth" (p. 119). In other words, technology creates new tools for use in scientific inquiry, and scientific discoveries fuel new and useful technologies—a highly synergistic arrangement.

Technology educators need to be clear about the implications of this relationship. Some cultures value knowledge—the kind you get from science or philosophy or religion—for its own sake. In our pragmatic society, science (and most everything else) takes its value from its usefulness. A case has been made for regarding science as a valuable commodity, with technology as its delivery system. This perspective brings us to a rather strange pass:

1. Technology education is a new discipline in this country. Its goals, values, processes, and products are unclear to administrators—indeed are not yet clear to its proponents.

2. Science is viewed as a lofty pursuit, a high status (and well subsidized) subject in the education world, so technology educators gravitate toward it and hope to acquire some of its luster by association.

3. Science is characterized by the rational and objective pursuit of truths about the natural world, a process more interesting to students when related to practical outcomes. Technology educators, hoping to further the cause of our field, offer technology as a way to enhance science education. Quite in contrast to advancing the case for technology as a field of study, this may reduce technology to a teaching strategy of science.

We know that the process of technology is more than a method of teaching science. We believe our field can make a unique contribution to the challenge of living in a technologically complex world. To achieve this goal, we need to take a broad and conceptualized view of technology. People can't control technology using only some of their faculties; they need to employ their eyes, hands, and a well-integrated brain. They need to learn to tap, trust, and value their feelings, their instincts, their senses, and their common sense.

In today's curriculum, art and science are seen as two ends of a spectrum. For pragmatic reasons, technology education has embraced science as a partner in the educational scene. One problem with this strategy is that it obscures a very fundamental connection with art. The craftswomen and -men who defined all the millennia of technology up to the industrial revolution applied a holistic understanding of the world to the problems they set out to solve—behaving very much as artists. Even today, in terms of process, technology is more like art than science:

1. The process of science rejects intuitive leaps and gut feelings; the processes of art and of technology thrive on them.
2. Science takes its limits from what is possible and claims no values; both art and technology must answer to taste and conscience.
3. The culture of science divides the world into thinkers and doers; to artists and technologists, thinking and doing are fundamentally intertwined.
4. Science's answers are presented as truths because they have been held up to the most rigid objective standards; like art, technology's solutions must undergo subjective judgment and appeal to human users or suffer rejection.

Recognizing our common ground with art allows us to tap several rich sources of creativity, so important to technology. Among these sources are the following:

- creative thinking processes emphasizing fluency, flexibility, and originality;
- trust in intuition;
- the satisfaction received from making, the joy of craftsmanship;
- imagination, a virtual world where "what if" scenarios can be played out and studied;
- skills of seeing and drawing;
- individuality and self-expression, an appreciation of mavericks.

Science has creative dimensions, but little time is spent in science classes developing these qualities. Creativity can be taught, and most people, if helped to do so, can access far more imaginative thinking than they realize. Technologists need intuition, imagination, and visualization skills to solve problems as much or more than they need scientific rigor.

A second dubious feature of science education is exclusivity. Science, like math and technology, has historically failed to capture the imagination of females. Both anecdotally and in formal research, females consistently report the importance of meaningful contexts for successful learning. The best technology programs in the United States and abroad present problems in interesting contexts that invite individual interpretation and instill a sense of ownership in student designers.

Technology educators, if we hope to prepare all students for successful adulthood, have much to learn in the area of inclusiveness—but not from science. We need to create an atmosphere in our laboratories more like that of the best art rooms, where diversity is valued; where students gain confidence in their creativity and their ability to express it well. In a good technology laboratory, students apply this same creativity to practical problems and develop a sense of responsibility for the consequences of their decisions.

If I were on a mission to recruit future technology teachers, I'd bypass the high school science laboratory and go directly to an art class. This approach flies in the face of current thinking, but for many of us, I believe it is our artistic inclinations that have drawn us to technology in the first place.

I do not suggest that we reject all connections with science, only that we not be blinded. Technology is a unique activity. As practicing technologists, we must learn to recognize what we value about designing and making, what fascinates us about problem solving, what pleasure we get from being creative. Then we will have gone a long way toward establishing something unique in schools, and the technology laboratory will be a place where young people like to go, and where they learn things of practical value. But until our field recognizes and reflects all the qualities technological people bring to the world, we will not be able to capture the imagination of young people and their parents, look inviting to non-traditional populations, or deliver the kind of preparation that coming generations will need to face the high-tech world.

REFERENCES

Mumford, L. (1964). From Erehwon to nowhere. In T. P. Hughes (Ed.), *The development of western technology since 1500* (pp. 17-26). New York: Macmillan.

Pearson, C. (1997). Making the renaissance work. *Architectural Record, 185*(12), 52-55.

Randall, J. H. (1961). *The school of padua and the emergence of modern science.* Padua: Editrice Antenore.

Turner, A. R. (1993). *Inventing Leonardo.* New York: Alfred A. Knopf.

Essay 26

The State Supervisor's Role in Managing National Change

Gregory C. Kane
Connecticut Department of Education
Hartford, Connecticut

The International Technology Education Association (ITEA) published two important documents during the latter part of the 20th century. Each publication had a significant impact on the profession. The first of the two documents to be published, *Technology for All Americans: A Rationale and Structure for the Study of Technology,* provided a foundation for a unified understanding of what is technology and what is technology education. It also provided a rationale as to why technological literacy should be an educational priority for all Americans. The second document, *Standards for Technology Education: Content for the Study of Technology,* identified what every student needs to know and be able to do in technology from grades K-12. In addition to these two publications, documents that provide standards for teacher enhancement, teacher preparation, student assessment, and program are scheduled to be developed and published by ITEA during the early part of the 21st century. Standards' documents alone, unfortunately, will not suffice unless other and more significant changes occur in technology education. These documents will end up on a shelf unless there is a nationally coordinated effort to move this body of work from concept to reality. I submit that the state supervisor for technology education must actively assume the role of change agent and accept the responsibility for moving the profession from a set of documents to actual practice. No other person serving in a capacity of leadership can bring about the change required to lead the profession into the 21st century.

Well before the arrival of the Technology for All Americans project, great strides had been made in transitioning curricula, facilities, and even teachers from industrial arts to technology education. Today, for example, schools have technology education departments, and classrooms are labeled with titles such as Communication Technology and Transportation Technology. Most professional organizations representing technology education now have the word technology in their names, such as the International Technology Education Association and the Connecticut Technology Education Association. Teacher educators are now preparing their students to be future technology education teachers and state departments of education are issuing technology education certificates.

As a result of all of our past efforts including the results attained by Technology for All Americans project, the profession is now provided with a solid foundation to bring about significant change. Now, more than ever before, there is a need to create a national effort of systemic reform to bring about the standardization of all aspects of technology education. In fact, from my perspective, the lack of standardization is one of the primary reasons why change in our profession today has been slow in coming. I recommend the following for your consideration as you participate in the development of our 21st century agenda: (1) Technology education goals and objectives in Texas should look like technology education goals and objectives in Virginia, Wisconsin, and California. (2) The teacher preparation programs at Ball State University, Central Connecticut State University, Colorado State University, and Illinois State University should be more similar than dissimilar. (3) The technology education standards students strive to achieve in New York should be the same standards they strive to achieve in Utah, Florida, and South Carolina.

The profession needs people in key leadership positions who are willing to facilitate systemic reform and who will work toward standardization in several different areas. I submit these people are state supervisors. State supervisors, for example, need to create opportunities in their states to increase the frequency and level of dialogue among educators, administrators, and governmental policymakers. With most state departments of education having an individual designated to serve as the state supervisor, the structure is in place to provide the necessary coordination and leadership to move from scattered local or state reform to systemic national reform.

Given the magnitude of curriculum reform required to enact the national standards, every state must first adopt state technology standards that are consistent with the national standards. From state standards, local education entities must adopt local standards that are consistent with state and national standards. Curricula must also be developed that will prepare students to master these standards. Currently, the state supervisor is called upon to present standards for adoption by state boards of education and to facilitate the adoption of like standards at the local level. As agents of the state chief education officer, state supervisors frequently consult with local districts in developing curricula related to standards. To ensure that our students can demonstrate mastery of the technology education standards, state supervisors must speak with a common voice and, with the assistance of our professional organizations, participate in national curriculum projects similar to those currently being undertaken in other content areas.

Most states have an oversight role in the development of new school facilities and once again, state supervisors are frequently called upon to review local plans. A common and consistent message is necessary if the facilities being built or renovated are to allow for the teaching of technology as presented in national, state, and local technology education standards. Realizing that facilities will differ, every effort must be made to ensure that people who oversee building projects do not replicate facilities that were built 20 years ago. As nationally developed standards for facilities are completed, it will be the state supervisor's responsibility, while working with state and local officials, to ensure that standards are followed in the construction and renovation of facilities.

State supervisors must work to develop consistency among their states when they monitor and oversee state certification and licensing regulations for technology education teachers. It is at this time that close coordination with teacher preparation institutions becomes essential if we are to provide pathways so graduates of technology teacher education programs in one state may easily seek certification and employment in other states. State supervisors are also in the position to work toward creating a standardized initial teacher support system that will ensure that any differences in preparation do not create barriers to successful classroom experiences. The state supervisor should work with local education agencies to monitor trends in staffing and must communicate these trends to national audiences to ensure a balance between teacher supply and demand. The state supervisor must also work with supervisors throughout the country to support the continuation of existing teacher education programs and the development of new programs. In order that local, state, and national agencies may attain their instructional goals, an adequate number of qualified technology education teachers must be a high priority for our 21st century agenda. The state supervisor is positioned to provide key leadership in this area also.

The state supervisor frequently provides the means for developing links between business and what goes on in the classroom. It is imperative that these links be expanded to call upon business to support technology education and to persuade education officials at all levels that technology education be required if our students are to be prepared for the workplace. Through the business community, policymakers can be influenced to support both conceptually and financially the creation, development, and/or revision of technology education programs at the local, state, and national levels. With the help of state supervisors, efforts initiated at the state level can expand nationally. Federal policymakers listen to American business leaders and it is through a state supervisor that a broad-based effort can be developed that will positively influence the business community.

As we move into the 21st century, the state supervisor is positioned to bring together the stakeholders needed to ensure systemic reform. From the adoption of standards to the licensing of teachers, state supervisors must collectively assume the key leadership role. Without a unified acceptance by state supervisors of the importance of this leadership role and the broad-based support from the profession, we will continue to be splintered, and the gap between theory and practice will remain with us well into the 21st century.

Essay 27

A Curriculum at Risk? The Identity Crisis Continues . . .

Linda Rae Markert
State University of New York at Oswego
Oswego, New York

You can't un-ring a bell! Think about that statement for just a moment. As simple as it may sound, it has a profound and significant meaning for a discussion such as this—one that revolves around identity. All of us have had numerous experiences where we wished we could take back something we had said to someone. That something had been taken the wrong way, out of context, or misinterpreted. And, regardless how much effort was expended to explain away the initial statement, its effect remained unmitigated.

Some 15 years ago a very loud bell was rung that ushered in a new name for our discipline and introduced its revised curricular mission. The new name was Technology Education. Since that time, I am certain some of its many proponents have second-guessed their collective wisdom in selecting this particular title for an applied industrial studies curriculum. Several of them may even be wishing the clocks could be turned back to the early 1980s whereby everyone could truly evaluate this new title—just one last time—before settling on it for good.

Those of us who have spent our lives devoted to this field now labeled technology education have spent an equivalent period of time defining or describing who we are and what we represent in the academic curriculum. I am beginning to wonder how many more years we must continue to struggle through an identity crisis before we feel confident the rest of society knows who we really are. Is technology education a curriculum forever sentenced to adolescence—a time of life when identity crises seem to prevail? Is technology education a subject that will never reach the adult status of core content areas like math, English, science, and social studies? Worse yet, is technology education a curriculum at risk?

Even though I have taught numerous undergraduate and graduate industrial/technological course topics throughout my 22 year career as a university educator, my mother continues to ask me, "What is it again that you teach, exactly?" Or, "Why don't you teach something that's easier for me to tell my friends about—you know, like history or English?" It is apparent that no matter how many times I describe to her (or anyone for that matter) what I teach, there is no easy label she can use to identify my job title. If she tells her friends I am a technology professor, they either assume I teach an introductory computer course, or they simply maintain their disinterest through silence.

In nearly every meeting I attend in my current administrative role, someone inevitably asks me about my academic background. These colleagues, who are from an array of educational institutions, governmental agencies, and corporate offices, generally have the same reaction to my degree titles, as do my mother's friends. Some of the most recent questions and comments about my expertise include the following:

1. "Does that mean you are a computer specialist?"
2. "Did you work as an engineer prior to joining a college faculty?"
3. "Oh, I know about that field, my brother also has a degree in instructional technology!"
4. "You're not what we used to call high school shop teachers, are you?"

It is doubtful our history or English colleagues are ever asked similar questions about their areas of interest or expertise. They may simply state what they teach and go on with the conversation. Generally, they are not required to explain what they do, define where their subjects fit in a student's educational program, or justify why their subjects even exist. Further, regardless of the fact that numerous specializations are found within these academic subjects (e.g., Analytical Geometry, British Literature, Asian Studies), the familiar labels ascribed to them have remained intact throughout the entire 20th century—the specializations were never at risk and they are not now at risk.

Conversely, the external profile for technology education curriculum is no where near as familiar or succinct, which may be why it is easily forgotten or ignored when it comes time to preparing legislation regarding teacher preparation. There is a problem with using a word like technology to name our curriculum. Many parents, administrators, legislators, and students remain clueless as to what is actually taught in the school's technology laboratories, why it needs to be taught there, and which students will benefit if they enroll in these classes (all of them of course!). Further, some writers actually believe that adding the word education to the title of any discipline has almost a denigrating effect. While it is highly improbable the leaders of our discipline will vote to change its name again in the near future, it is unfortunate that technology and education are examples of words in our society that have been used, overused, and misused to the extent they have no specific meaning or defined boundaries. Technology, sort of like Kleenex, has become a household word that everyone has a right to use in whatever venue makes sense at the time. It is no wonder technology education professionals continually struggle to obtain a sense of identity or achieve equal footing with their arts and sciences co-workers.

Many of us are long-standing members of the International Technology Education Association (ITEA) and National Association of Industrial Technology (NAIT). Leaders of these associations have been proactive while lobbying in Washington, D.C. for recognition on a number of issues. Each organization has sponsored national projects largely designed to promote public awareness of a critical academic subject that many people fail to grasp or even understand. At the state level, for example, the New York State Technology Education Association (NYSTEA) lobbied extensively for the inclusion of technology education as a high school graduation requirement. In an effort to support their position, a copy of ITEA's videotape titled, *Technology Education: A New Paradigm*, was sent to key legislators, State Education Department representatives, and all members of the Board of Regents. Despite this aggressive level of commitment and energy to educate New York's public, technology education was not even mentioned in the 1998 Regents Task Force on Teaching document titled *Teaching to Higher Standards:*

New York's Commitment. Among numerous other significant mandates regarding teacher preparation, this document reveals a totally revamped listing of certificates, extensions, and annotations for classroom teachers that are recommended to be effective February 2, 2003. Teacher education institutions are instructed to modify their programs accordingly by September 2000. As I reviewed this lengthy list of new certificate titles, I wondered where the technology education subject would be placed. Since it was not listed by its own name, I selected three entries that looked to be potential areas of inclusion. They read as follows:

- Work Force Preparation, Grade 5 to Grade 12 (e.g., agriculture, business education, avionics, electronics and computer programming)
- Special Subject, Birth to Grade 12 - Subject or Interdisciplinary (e.g., music, health education)
- Educational Services, Birth to Grade 12 (e.g., educational technology, library service, etc.)

My personal margin notes placed the cursive *Technology Education??* alongside the Special Subject listing. I placed a call to the State Education Department to determine whether or not my assumption was accurate—it was. Nevertheless, my naive belief that we were finally getting somewhere in our continuing struggle to be identified as an essential school subject was shattered.

This essay is about identity. It is about meaning. It is about public awareness. A child whose educational experience is devoid of technology education is a child who is not liberally educated. If this curriculum we value so greatly is at risk or in jeopardy, a significant part of the problem lies in the public's misperception about our mission.

Just about five years ago while attending a leadership development conference sponsored by the Technical Foundation of America, I learned that an articulate mission statement should define the following:

- What you do
- For whom
- Your uniqueness
- Your contribution to society
- What you are especially good at

In this context, I believe the mission of our discipline is to instill in students a dynamic curiosity for how to make things better in a technology dependent world. Technology educators are especially good at designing applied industrial activities that inspire problem-solving behaviors and promote technical literacy for all persons. Therefore, technology education is best viewed as an ever-emerging field of study that delivers lifelong opportunities for the preservation of a technologically literate citizenry.

No one can dispute the importance of problem solving, decision making, and creative thinking skills in a world where constant change is the norm. These skills are best achieved through action learning exercises replete with contemporary world applications. But of course YOU all know this! Once again, I find myself preaching to the choir in an effort to educate and convert the congregation.

Yes, folks, even though I may prefer a different label, it is too late to change our name. As we approach the third decade of using the Tech Ed moniker, perhaps a different strategy is necessary to move technology education out of this perpetual identity crisis—both within the academic community and in our society at large. It may seem that nothing short of convincing Oliver Stone to direct a feature length blockbuster film starring Robin Williams as a high school technology educator who inspires his students to design exceptional solutions to real world problems will work at this point.

The challenges ahead are far more manageable than the challenges in our 15-year wake. However tempting it might seem to some of us, we cannot afford to give up the fight for technology emphasis curricula at all levels of educational preparation. If you subscribe to the mission statement presented here, do not be silent in any forum. Eventually, I believe our collective voices will be resonant in the minds of those outside our discipline. All technology educators must be respected as participants in and contributors to the academic community. This is a critical aspiration as we move cautiously ahead into the 21st century. The bell that pronounced technology education to be a curriculum for all Americans cannot be un-rung! And it shouldn't be . . . ding!

REFERENCES

International Technology Education Association. (1997). *Technology for all Americans: A rationale and structure for the study of technology.* Reston, VA: Author.

Regents Task Force on Teaching. (1998). *Teaching to higher standards: New York's commitment.* Albany, NY: The University of the State of New York, The State Education Department.

Thompson Learning Tools (Producer). (1996). *Technology education: A new paradigm* (Videotape). (Available from International Technology Education Association, 1914 Association Drive, Reston, VA 20191)

Essay 28

The Changing Demographics in Technology Education

Charles A. Pinder
Northern Kentucky University
Highland Heights, Kentucky

Revolutionary changes are on the horizon in the technology education profession in the United States. These changes will happen, for the most part, during the lifetime of most individuals who are alive today. While counter-instances have been cited by several doomsday predictors as evidence that these projections cannot be made successfully, they are all unconvincing. Nonetheless, the changing demographics in America form an intellectual substructure for thinking about revolutionary changes in the technology education profession by the year 2008.

In this essay, I will (a) provide you a snapshot of the demand for technology teachers; (b) identify some characteristics of individuals of the millennial generation; (c) underscore the importance of identifying and educating women and minorities to be technology teachers; (d) discuss the gender shift on college campuses; and (e) identify some projected impacts of redistribution by gender and race in technology teacher education programs.

The demand for technology teachers in America is a topic of paramount importance. At a time when enrollment in and graduation from technology teacher education programs are declining rapidly, the demand for technology teachers is escalating. It is estimated that by 2007, student enrollment in colleges and universities will grow to 54 million, an increase of 7% from 1995 (U.S. Department of Education, 1997, p. 8). According to Weston (1997), the technology education profession will need approximately "13,000 additional teachers by 2001." Nevertheless, teacher education departmental productivity in terms of total graduates produced changed little during the past 30 years. Furthermore, during the past 3 years, 9 technology teacher education programs failed to produce any new teachers and 21 programs (19%) in 1997-98 reported 0 graduates.

In spite of the demand and productivity problems prevalent in technology education, I predict that a revolutionary shift is about to take place in the supply of new teachers for our profession. These problems can and will be solved by bold and visionary action in the manner by which we recruit and educate a diverse population of new teachers. To be sure, members of the technology education profession must take proactive and creative measures that will serve the profession best during the first decade of the new millennium. This major transformation will be impacted by the millennial generation. I strongly encourage leaders in the technology education profession to bring together the major stakeholders to develop the measures necessary to address the demand and productivity problems that are prevalent today. These measures cannot be developed, however, without first giving serious consideration to the characteristics of those individuals who comprise the millennial generation.

The millennial generation consists of individuals aged 4 to 21 in 1998. This generation is "ambitious, optimistic and altruistic" (Mitchell, 1998, p. 83). They have already begun to have a profound impact on the educational systems in America. They appear also to be highly accepting of diversity. (In this essay, diversity includes an environment where all differences are valued and all people are encouraged to realize their full potential.)

The number of individuals who are in the 18 to 22 age group and who are racial or ethnic minorities will rise to approximately 35% in 2000 and 40% in 2015 of the total population in the United States. This projected rise in population reflects substantial increases in the number of Hispanics, Asians, and Blacks due to immigration and higher birth rates. In addition, women are projected to comprise 48% of the workforce by 2005 (United States Department of Labor, 1996, p. 5).

It is this author's opinion that identifying and educating women and ethnic minorities to be technology teachers is most relevant, because taking account of individuals from diverse backgrounds will enhance the exchange of new ideas and advance the creation and dissemination of knowledge. Diversity will also help members of the technology education profession address the supply and demand for new technology teachers during the next several years.

Diversified investment portfolios usually contain a mixture of stocks, bonds, and other commodities. Similarly, good baseball teams include excellent hitters and sturdy defenders along with infielders and outfielders. Moreover, when making a stew, adding several peas and carrots rather than one more potato may make excellent sense—and be eminently fair—since mostly potatoes are presently in the pot. These analogies are cited to draw specific attention to why the profession needs to change course and prevent undesirable consequences from happening.

Prior to 1980, the number of men in college significantly outnumbered women. However, beginning in 1982, the college enrollment rates for women surpassed men in all age groups. According to the National Center for Education Statistics, this trend will continue well into the 21st century.

Redistribution by gender is happening at numerous traditionally co-ed colleges in America, as well as at previously all male institutions. It is also clear that a larger number of women are enrolled in previously male dominated programs.

Redistribution by gender and race in technology teacher education programs in America by 2008 becomes a strong possibility—if not a certainty. However, a wide range of strategies will be required to recruit them in significant numbers. Now, more than ever before, we need the major stakeholders to come together to help us identify, develop, and then implement these strategies.

Technology education lags behind the scientific and engineering disciplines in encouraging women and minorities to join the profession. Nevertheless, it will be evident that going to college and participating in the learning process only with the likes of oneself will be increasingly anachronistic.

We must begin to work together to create the missing conditions and to assist with the formation of missing agents if we are going to survive as a profession. If we do not recruit and graduate a disproportionate number of young women and minorities into the technology education profession by 2008, our profession may no longer exist in any state by 2018. Therefore, recruitment of women and minorities must be in a high position on the 21st century agenda of every technology educator in the United States today. I challenge the major stakeholders in technology education to make it that way. It will take their bold and creative leadership—nothing less is acceptable.

REFERENCES

Mitchell, S. (1998). *American generations–Who they are, how they live, what they think.* New York: New Strategist.

United States Department of Education. (1997). *Projections of education statistics to 2007* (Center for Education Statistics NCES 97-382). Washington, DC: US Government Printing Office.

United States Department of Labor. (1996). *Occupational projections and training data* (Bureau of Labor Statistics Bulletin 2471). Washington, DC: US Government Printing Office.

Weston, S. (1997). Teacher shortage–Supply and demand. *The Technology Teacher. 57*(1), 6-9.

Essay 29

From Fluid Mechanics to Fluid Intelligence

William S. Pretzer
Henry Ford Museum & Greenfield Village
Dearborn, Michigan

The title I have given this essay is meant to suggest two distinct themes. First, drawn as it is from the fields of art and science education, the term "fluid intelligence" opens the door for a discussion of the influence of affective learning, the importance of sensor-motor learning, and the expressive role of technology that parallels the expressive role of art. Second, a turn-of-the-millennium shift in educational emphasis from content to skills is predicated on a broader cultural shift in the nature of knowledge and learning brought on by the digital revolution. From now on, what is taught and how it is taught will become ever more inextricably intertwined. Or, put more bluntly, students will learn when, where, and how they want; teachers won't be teaching anything, at least, not as they have been for the past century.

Fluid intelligence is Elliot Eisner's term for the kind of mental processes that the study of art promotes. Eisner attributes the idea to John Dewey's concept of "flexible purposing" and to science educator Joseph Schwab's constructivist approach to learning (Eisner, 1999). It is an approach which recognizes gray as well as black and white; that recognizes when right and wrong are absolute and when they are relative; that refuses to accept simplistic answers but treasures simple, elegant solutions. It is what Thomas Edison imagined when he criticized the educational system of his era for not cultivating "the elasticity of the mind."

I am struck time and again of the similarities between the methods and goals of art educators and technology educators. Art (particularly visual art), not science and math, seems to be technology's disciplinary and cognitive mirror-twin. In their most basic form, the national educational standards for the Visual Arts, as proposed by the Consortium of National Arts Education Associations (1994, pp. 69-72), include the following:

1. Understanding and applying media, techniques, and processes
2. Using knowledge of structure and functions
3. Choosing and evaluating a range of subject matter, symbols, and ideas
4. Understanding the visual art in relation to history and cultures
5. Reflecting upon and assessing the characteristics and merits of their work and the work of others

Like technology, art can be perceived as one of the humanities and studied through the processes of creation, communication, continuity, and criticism. Conceived thusly, it would be as important for students to learn how to communicate about technical systems verbally as it was visually and mathematically; it would be as meaningful to criticize systems as to create them; it would be useful to see where in the chain of technological change one's own creations resided.

Fluid intelligence could be an aim of all education, habits of mind that are judicious, supple, and generous. This mind-set is not hard and potentially brittle like steel but flexible like nylon. It does not think the world works like a machine with simple input, throughput, feedback, and output. It doesn't even think machines work like this.

In *Growing Up Digital: The Rise of the Net Generation*, Don Tapscott has identified eight shifts in learning that he attributes to the development of personal computer networks:

1. From linear to hypermedia learning
2. From instruction to construction and discovery
3. From teacher-centered to learner-centered education
4. From absorbing material to learning how to navigate and how to learn
5. From school to lifelong learning
6. From one-size-fits-all to customized learning

7. From learning as torture to learning as fun
8. From the teacher as transmitter to the teacher as facilitator (1998, pp. 142-149)

Whatever one thinks of computers in the classroom, there is no denying that today's students will use and be influenced by computers everyday for the rest of their lives. The relevant issue here is not how to integrate computers into technology education but rather how to alter the learning experience to take advantage of the shifts digital technology has wrought.

The irony is that the digital world also seems to make the real world more abstract and distant for many young people. Accustomed to working with a computer, they rarely get their hands dirty or directly on primary sources or authentic materials. In the design process, especially, it is important not to forget the real for the virtual. Technology education is well positioned to be a leader in education by asserting the primacy of the real, and the really important, for the virtual. As Carl Mitcham (1995) points out, the problems of design are ethical as well as technical and aesthetic.

There is also irony in the fact that technology educators, once they get past the Harold Bloom-inspired "taxonomy of knowledge" approach, are well positioned to be role models in their schools for new teaching methods. Technology educators are constantly developing student projects drawn from real-world circumstances; they commonly employ team or group action, and they frequently assess students on the basis of actual performance or demonstration that includes a tangible product.

School reformer Phillip Schlechty (1997) has suggested that the real work of teachers is to make interesting work for students that provides students with the opportunity to create knowledge and skills that adults think are important. It is hard to identify a subject area in which there are more opportunities for creative, real-world work that involves a greater range of skills and knowledge than technology. This is especially true if one thinks about the entire scope of technological studies, from inventing and designing, to fabricating and using, to assessing impact, to placing in historical and social context, to communicating about all of these issues to others.

One of the strengths of technology education is that it focuses students' attention on the future, not the present or past. As such, it draws on the natural inclinations of young people to imagine themselves as influential, makers of their world. Another strength of technology education is that, like art education, it relies on an intimate relationship between mind and body, particularly the hand. In *The Hand: How Its Use Shapes the Brain, Language, and Human Culture,* Frank Wilson puts it this way:

> When personal desire prompts anyone to learn to do something well with the hands, an extremely complicated process is initiated that endows the work with a powerful emotional charge. People are changed, significantly and irreversibly it seems, when movement, thought and feeling fuse. . . .How does, or should, the education system accommodate the fact that the hand is not merely a metaphor or an icon for humanness, but often the real-life focal point—the lever or launching pad—of a successful and genuinely fulfilling life? (1998, pp. 14 & 277)

Tapscott's list of the attributes of interactive learning is surprisingly close to Schwab's constructivist approach to learning (Armstrong, 1998; Schwab, 1969):

1. Student's work to solve problems of their own or their teacher's construction
2. Students work in and out of class
3. Teachers serve as helpers, guides, and resource providers
4. Students often work in teams
5. Students seek to learn process as well as discrete product
6. School is modeled after real-life solution seeking
7. Parents and community are important associates in student learning
8. Open ended activities means there will be a variety of appropriate solutions

Ironic, isn't it? At the turn of the millennium, when technology is on everyone's mind, the technology education profession is in a quandary, not quite sure of its goals and direction. The age of electronic communications is dissolving traditional academic disciplines, an organization of knowledge firmly rooted in the culture of the printed book. And technology educators, having rhetorically shed their vocational/industrial arts heritage just a generation ago, now find themselves defining their profession as an academic discipline.

The United States is the most materialistic nation on earth. It is also the most technologically sophisticated nation on earth. The United States has a history of technological invention and innovation rooted in both the uncommon genius of individual inventors and common acceptance of new technologies. No one, to my knowledge, has ever argued that technology education or its predecessor, industrial arts, has had much, if anything, to do with this situation. Ironic, isn't it?

Popular Mechanics, the populist technology educator of choice for American males for the last 100 years, is one of the largest selling over-the-counter magazines in the country. Our national media never tires of pointing out that technology is both a major contributor and a major obstacle to human progress. Cable television produces shows like "Beyond 2000" and "The Secret Life of Machines." Hundreds of thousands of people, young and old, visit the hundreds of science-and-technology centers around the nation each year. Yet, in a nation obsessed with technology, saturated with media coverage of technological issues, and where school districts offer signing bonuses for new technology educators, colleges and universities are closing rather than expanding technology teacher education programs. Ironic, isn't it?

Through the first two-thirds of the 20th century, industrial arts existed firmly within the vocational track of the American high school. Educational theory and practice institutionalized the separation between an intellectual elite that was prepared for higher education and the vast majority of students who were prepared for the workforce. Today, there is no reason to harp against the vocational/recreational approach to industrial arts in schools. Wood shop, metal shop, and auto shop exist as atavistic remnants of the 20th century educational structure, catering to exclusively masculine vocations. They won't last long into the 21st century anyway.

To move from teaching fluid mechanics as a subject matter to teaching young people to think fluidly is the goal of technological studies in the early years of the 21st century. Technology education in the K-12 years is no more about pre-engineering than math is about pre-accounting, English about pre-journalism, or science about pre-medicine. We don't assume that all students should study math, language, and science because we expect them to enter one of those professions. Regardless of their ultimate occupations, we expect productive citizens to be able to calculate, communicate, and recognize the workings of the natural world. Those disciplines are important because they are useful to the individual and to the society. We want all students introduced to technology so that they can recognize the workings of the designed world and function in that world.

REFERENCES

Armstrong, T. (1998). *Models of teaching.* EDTE 524. Idaho Virtual Campus (On-Line). Available: http://vanguard.phys.uidaho.edu/mod.

Consortium of National Arts Education Associations. (1994). *National standards for arts education.* Reston, VA: Music Educators National Conference.

Eisner, E. W. (1999, January 25). Personal Communication.

Mitcham, C. (1995). Ethics into design. In Richard Buchanan & Victor Margolin (Eds.), *Discovering design: Exploration in design studies* (pp. 73-189). Chicago: The University of Chicago Press.

Schlechty, P. C. (1997). *Inventing better schools: An action plan for educational reform.* San Francisco: Jossey-Bass.

Schwab, J. J. (1969). The practical: A language for curriculum. *School Review, 78,* 1-24.

Tapscott, D. (1998). *Growing up digital: The rise of the net generation.* New York: McGraw-Hill.

Wilson, F. R. (1998). *The hand: How its use shapes the brain, language, and human culture.* New York: Pantheon Books.

Essay 30

Power Play or No Play?

Mark Sanders
Virginia Tech
Blacksburg, Virginia

One of the penalties for refusing to participate in politics is that you end up being governed by your inferiors.—Plato

You must either master politics or be mastered by those that do.—Anonymous

In 1998, the Disney Company was about to lose its exclusive rights to Mickey, Donald, Goofy, and Pluto. There was nothing Mickey Mouse about the company response. The Chair of the Board went to work on the Senate, contributing generously to 18 to 25 key legislators and enlisting lobbying support from the president of the Motion Picture Association of America. They were convincing. Congress voted to extend corporate rights an additional 20 years. Political action is a powerful tool.

State legislatures and Boards of Education across the United States have joined the education reform movement, implementing a multitude of new initiatives and mandates. Here in Virginia, for example, the state Board of Education developed and implemented new "Standards of Learning" (SOL's) and a statewide testing program. Schools in which fewer than 70% of students pass the SOL's tests will not be accredited. As a direct result, Virginia schools are overhauling their curricula to address these new Standards.

Politically motivated change in education isn't new. In the early 1900s, America needed skilled workers, and the Smith-Hughes Act spawned vocational education. The Soviet Union launched Sputnik, and America launched the educational reform movement of the 1960s. More recently, the United States bombed in the international rankings in science and mathematics, and the current education reform movement mushroomed. Educational change in America is a product of political action and reaction.

We have a motion on the table: technological studies for ALL Americans. This is an important and powerful message that, if understood, would be supported by the people. But we haven't convinced the masses. Thus, only some boys and fewer girls in too few schools get just a glimpse of technology education at some time during their K-12 experience. That's not good enough for the new millennium. We want technological studies for all Americans, and we're not going to get there the old-fashioned way.

Don't get me wrong. I think the promotional materials that the International Technology Education Association (ITEA) has developed over the past decade are the best we've ever had. Annual rollouts of upbeat videos such as "Technology Education: The New Basic" and publications the likes of *Technology for All Americans: A Rationale And Structure for the Study of Technology* have provided us with good tools for educating the public. But who sees our propaganda? Mostly those within the profession. We share these materials, for the most part, with our current or prospective students. Since we rarely venture out of our ordinary venues, few outside our field ever see what we have to offer. When they do, they generally like what they see.

But let's face it. We do not have the resources to reach the masses with our message, thereby effecting technological studies for all Americans. Even if we did, it's the wrong strategy. A media blitz makes sense if our goal is simply image enhancement. But we're after more than image. We want prime time in the school curriculum. We want every child to benefit from an articulated K-12 technological studies curriculum. We're not talking incremental change. We're not talking evolution. Technological studies for all Americans is a radical idea. Implementing radical ideas calls for radical action. We must get political.

It's not going to be easy. Clearly, the public's perception of technology is distorted. On the one hand, the public equates technology with computers. On the other hand, they think whatever technology is, it belongs in science. *Popular Science* magazine reports far more technology than science. America's longstanding fascination with NASA space missions has far more to do with the technology it flaunts than the science it conducts. It will be difficult to convince anyone that technological studies shouldn't just be another chapter in the science textbook.

Technology competitions have also enhanced the image of science education as technology education. With more than $1 million of corporate support annually, the Duracell/NSTA Invention Challenge, Toshiba/NSTA ExploraVision Awards Program, and Craftsman/NSTA Young Inventors Awards Program engage K-12 science students in highly visible technology-based competitions. Boasting many tens of thousands of dollars in scholarship awards each year, these competitions are highly effective advertisements for technology in science.

Compounding our dilemma is the fact that the study of technology is now recognized and promoted as a major thrust of science education. Content Standard E of the *National Science Education Standards* calls for K-12 technological design and problem solving—our brand of technology education—within the science curriculum.

To be sure, technology education being subsumed by science education isn't all bad. It would assure that every child has opportunities to read about and discuss technology. They would benefit from activities of the toothpicks-and-glue variety, and from digital technologies. But if technology education is required only in science classrooms, the richness of the laboratory experiences currently offered by our field will be vastly diminished or neglected altogether. Science instruction often regresses to lecture and discourse. There simply isn't time for sufficient hands-on technological problem solving in the science curriculum. This, I believe, is the downside of technology education occurring within the science curriculum.

Though we believe that requiring technological studies—as we practice it—of all students in all grades would greatly improve the education our children receive, our only chance of accomplishing this goal is to step up our political activity. Rather than mount an advertising campaign to reach the many, we need to educate the few who have the power to influence real change in education. The Technology for All Americans project has opened many doors. We must now storm through with unprecedented fervor.

Political action isn't totally new to our field. In the 1980s, for example, the New York state legislature passed a middle school mandate that required each student to complete 40 weeks of Technology Education by the end of 8th grade. Similarly, Maryland enacted a high school requirement for technology education.

Recently, I asked state supervisors of technology education to describe political activities occurring in their respective states. I was surprised to hear just how successful some individuals and state associations have been in their efforts to attract support. If money talks, Florida and Mississippi are engaged in the conversation. The Florida and Mississippi legislatures provided $55 million and $42 million of support respectively for equipping technology education laboratories and funding in-service education for technology teachers.

Technology educators in many states have begun aggressive lobbying efforts. In 1993, the Technology Education Association of Massachusetts (TEAM) hired a lobbyist and convinced a single state legislator to serve as an advocate. They telephoned many other legislators and were successful in getting technology education language included in the Education Reform Act of 1993. More importantly, they successfully lobbied for our definition of technology education in the amended 1994 Act. The TEAM continues to be politically active, and has a reputation as such.

The Virginia Technology Education Association (VTEA) Legislative Action Committee began lobbying efforts in 1997. In 1998, they were successful in obtaining high school science credit for Principles of Technology courses. They also lobbied successfully for the inclusion of technology education language in educational reform legislation, though the final language was less helpful to our field than was originally hoped. Nevertheless, the potential of political activism became apparent, and the VTEA Legislative Committee remains active.

In March, 1998, the Connecticut State Board of Education approved "K-12 Standards for Technology Education." In addition, Technology Education was included in the Connecticut Common Core of Learning, which outlines what every student should know and be able to do upon graduation. Connecticut and New York are formulating new strategic alliances with the corporate sector and the engineering community through Project Lead the Way (PLTW). PLTW introduced five high school pre-engineering courses taught by technology educators. In Connecticut, businesses have provided funding for technology education laboratory equipment in amounts up to $50,000 per laboratory as well as paid internships for PLTW students.

The Georgia Technology Education Association worked with one legislator who proposed four separate bills supportive of technology education. The Texas state technology education association hired a lobbyist to work on its behalf. Technology educators in New Jersey began working with the Chamber of Commerce to influence state-level policy.

At the national level, the ITEA formulated a list of 80 associations with whom they interact on a regular basis, working most closely with the NSTA, NASA, NCTM, NRC, NAE, NAS, NSF, NASSP, & NAESP. This is an important and unprecedented initiative in our field. These new partnerships have generated some new opportunities for our profession.

Political action, where undertaken by our field, seems to be working. Strides have been made with state legislatures, boards of education, corporate partners, and other professional associations. A political power play is our best hope for achieving the goal of technological studies for all in the new millennium.

Epilogue

Overt outward political action has long been thought of as unsightly in our field. The charter of the Southeast Technology Education Association—and probably other organizations in our field—specifically states that no political action will result from the work of the association. This seems remarkably shortsighted. If a primary purpose of a professional organization is to improve the status of the profession, political action should be a primary means of doing business. If not, we can expect no better than our current role in education—an elective subject struggling to achieve the status we deserve.

Technological studies will be taught in the schools of the 21st century, simply because we live in a time when technology permeates every aspect of our lives as never before. Technology education isn't just as important as science education; it's more important. If we don't make a political power play to become the primary means of delivering technology education in grades K-12, this role will default to science education. What then will become of our field?

Essay 31

Knowing Where You're Going!

Anthony E. Schwaller
St. Cloud State University
St. Cloud, Minnesota

Pause for just a moment and imagine the creative process an artist follows to sculpt and mold a clay statue. As each part of the statue is carefully shaped, the artist continually steps back to view the sculptured art work. In some instances, this happens every few minutes or literally every few seconds, depending on the detail in the sculpture. Can you imagine what a statue of a horse would look like if the artist didn't continually check his/her work? The legs might be too thick, the tail too short, or the body too large.

Every day of our lives we participate in activities that involve the application of our creative talents. For example, our participation may involve painting pictures, designing products, or landscaping yards. When we engage in activities like these, we are actively involved in the creative process much like the artist who is sculpturing the horse. It is only natural that we would continually step back to assess how we are doing. As you can see, "knowing where you're going" is important.

Technology educators, like artists, actively engage in the creative process when they teach subject matter and facilitate ways to improve the teaching and learning environments. As a student preparing to be a technology educator, we are taught to design, adjust, create, and establish different ways to teach our subject matter. The process helps us be effective teachers with our students. As facilitators, we constantly search for new and innovative ways to improve the learning environment. As you can imagine, it is very important that technology educators exhibit creativity in the subject matter they select to teach and the learning environment they design and develop.

Unlike the artist, many teachers never take time to step back to assess how they are doing. Unfortunately, some teachers don't even know how they or their students are doing until the final examination is administered. By that time, it's too late to make adjustments in the teaching process to positively affect students in the course. A teacher who doesn't pause to assess how the educational process is progressing cannot possibly change along the way. In turn, the students and teacher may not be meeting the goals and objectives established for the course, unit, or program.

The "stepping back" process that creative teachers engage in is called assessment. Today, assessment is a term closely associated with a wide range of organized activities that are used to measure educational effectiveness. Assessment helps teachers identify the effectiveness of their own instructional practices and of the goals of the course and department. It also helps teachers identify the gaps between what we as technology teachers want the students to learn (our objectives) and what the students actually learned, early enough to at least narrow the gaps.

Technology educators commonly employ two types of assessment—classroom and program. When we engage in classroom assessment, we are assessing teaching effectiveness and student achievement within the classroom. The point in time in which the assessment takes place in the classroom is very important. For example, if assessment occurs at the end of the teaching and learning process, corrections cannot be made until the following term. When we measure student achievement in relationship to the total program, we are engaging in program assessment. Classroom assessment is considered grass roots assessment whereas program assessment is directed towards state and national standards and guidelines. Both types of assessment are a necessary part of an organized assessment initiative.

Formative and summative assessments are also important parts of a comprehensive technology education assessment effort. Since formative assessment occurs continuously throughout a learning process, it allows for instructional change or corrections along the way. Summative assessment usually occurs at the end of a learning process and is generally used for administering a unit or final examination, assigning grades, or determining a student's class ranking. Unfortunately, summative assessment does not help the teacher alter or change the teaching and learning environments for those students already in the course.

The technology educator must know the purpose, audience, and timing of the assessment in order to know which type of assessment to use. Here are some general guidelines you may wish to follow. The purpose of formative assessment is to improve the course at any given moment in time. The purpose of summative assessment is to aid teachers with accountability, grades, selection, and promotion. The faculty who are engaged in the teaching process are the audience for formative assessment. The audience for summative assessment is school administrators, parents, and/or people external to the learning process. The timing for formative assessment is usually ongoing and during the teaching and learning process. The timing for summative assessment is at the completion or end of the course or program of study.

As you reflect on what you have learned about assessment in my essay, what type of assessment is occurring during the sculpturing of the clay statue of the horse? Since the artist is continually making changes along the way, the artist is using formative assessment.

Assessment and evaluation are terms often used interchangeably even though they do not have the same meaning. While all technology education teachers have been taught how to evaluate their students, not all teachers have been taught how to assess their instructional performance—or even how to assess student performance in the classroom. Evaluation is a summative process that may include administering multiple choice tests, true/false exams, essay exams, etc. Each is an evaluation instrument, not an assessment technique.

There are many summative and formative assessment techniques. Examples of summative assessment techniques (often used for program assessment) include standardized tests, exit interviews, placement rates, grades, and surveys of graduates. There are also many types of formative assessment techniques including focus groups, portfolios, oral exams or discussions, behavior observation, and Classroom Assessment Techniques (CATs). A focus group is a formative assessment technique whereby the technology teacher meets with students in small groups to determine the level of instructional effectiveness and student academic achievement. How effective can a focus group be? Several years ago I taught a two-hour, early morning course on energy technology. It was difficult to understand why the students were so disinterested in the course content. I lectured on a particular concept the first 30 minutes and then sent the students to the laboratory for the remaining part of the two hours. I felt the lectures were a failure so I finally decided to have a focus group to determine how I was doing. The focus group revealed that when students came to my 8:00 a.m. class, they were still tired. The students suggested having a laboratory experience first, followed by the lecture. I tried that approach and found that the students increased their interest in the course. The level of learning also increased. In this example, the focus group was used as a type of formative assessment. It was done early in the course so students could benefit from the changes that I had instituted.

Classroom Assessment Techniques (CATs) provide teachers with feedback about their effectiveness as teachers while still providing the teacher a measure of student progress. The two-minute paper is one type of CAT in which students are asked to write the most important thing they've learned in the past hour. The results are not graded. However, the teacher can determine at what level the concepts are being learned and adjust the teaching style accordingly. I have provided you a few examples of formative and summative techniques in this essay. Can you identify other examples that you have used?

Technology education teachers must be able to step back and assess their students, programs, and even themselves. While educational program goals and standards provide a guide; unfortunately, we still have a difficult time determining if the program goals and standards are being met. If we as technology educators first establish an intrinsic need for assessment, we will have a stronger and more opportunistic future—one that will lead the way with assessment. If we choose not to follow this path, we will not know if we are meeting the goals and standards we have set. In this case, as a profession of technology educators, we will flounder and drift away from our established goals and standards.

As our profession moves toward a more comprehensive assessment initiative, it must first provide technology educators with a sound knowledge of definitions, purposes, techniques, and benefits of conducting assessments. Once this is completed, the profession must continue a strong assessment initiative in order to maintain its orientation to the future. I believe that assessment must be a very high priority on our profession's 21st century agenda.

As you prepare to enter the third millennium, don't you think that "knowing where you're going" is important? You will need valuable guidance—so move cautiously. I contend that if you initiate quality assessments and continue with them throughout your career, you will be better informed on how you are doing—at any given moment in time.

Essay 32

Technology Education for Some Americans?

Michael L. Scott
The Ohio State University
Columbus, Ohio

Have you ever wondered why so few persons of color are participating in our profession? Why are they not participating in the International Technology Education Association (ITEA) and its conferences, in state associations and their conferences, or even in local associations and their conferences? Why are "teacher-of-the-year" or "program-of-the-year" recognitions devoid of participation from representative numbers of African Americans, Latinos, and Native Americans? It hasn't always been that way.

In the 1950s and 1960s (the author is too young to remember the 1940s), industrial arts enjoyed a strong presence in large urban cities in the United States (where large numbers of minorities live). Granted, a majority of urban teachers were non-minority, but the number of minority teachers then seemed to out-number the number of minority teachers today. Many of our large cities had impressive technical high schools (e.g., Lane Tech in Chicago) in which urban youths studied technological education along with a very rigorous curriculum of courses such as physics, chemistry, geometry, and advanced algebra or trigonometry. These were not trade schools (some of us came from such schools), but preparatory experiences for college and future careers in fields like engineering, education, and science.

Even in the non-technical urban high schools industrial arts was well represented. In the late 1960s and the 1970s when I taught industrial arts in Ohio, industrial arts was well represented in Ohio's urban school districts such as Cleveland, Columbus, Cincinnati, Dayton, Toledo, and Akron/Canton. At the state conference, teachers and students from these school districts were regular participants and award winners. At the national level, cities such as St. Louis, Chicago, Pittsburgh, Los Angeles, and Milwaukee were very visible. Again, not all were represented by minority teachers, but they were providing technology education for minority students. Where are these programs today? Do they still exist?

Technology education has enjoyed tremendous growth in suburban areas in our nation's schools. The suburban areas around my city (Columbus, Ohio) are growing so quickly that we can't build schools fast enough to accommodate all students. These schools are by and large, the "crème de la crème." Many resemble modern learning campuses replete with impressive facilities. When I (or my colleagues) want to showcase examples of exemplary technology education programs, this is where we take people. It is in these schools that new computer (and modular technology) labs have been installed. Here, kids learn from the finest teachers and their scores on state proficiency tests are the highest. Integration occurs between courses like math, science, and technology education. Teachers and programs from these districts are nominated (and rightly so) for program and teacher-of-the-year awards. Since some minority families have attained upper-middle class status, they have been able to live in these school districts and their children benefit. But, their numbers are pale in comparison to the minority families who still live in our urban areas.

Now, one could counter argue that such conditions do exist in urban schools. It is true that one can find isolated examples of excellence in some urban schools. But, the point is that compared to two and three decades ago, technology education has declined in urban areas. There are many examples that are indicative of this decline.

Many of today's urban schools do not have technology education programs. Programs that exist are very traditional, understaffed, and under equipped. Admittedly, there are a few shining stars in our urban schools, but these seem to be the exception, not the rule. Technology education programs have been cut back or eliminated to place more emphasis on basic academic skills where large groups of minority children are failing miserably. Facilities that house technology education programs are often in older buildings which are often in a state of disrepair. As we have moved out of the cities, so has our wealth and tax base which support, in part, urban schooling.

To understand what an extraordinary problem this has become, imagine what the future of our country will be like when a whole segment of its population is denied education about technology. Clearly, history shows us that civilizations which survived were those in which its citizenry became accomplished in the knowledge of technology. Emerging technologies of the 21^{st} century will affect employment, education, health, and personal growth. The economic and national security of the United States will weigh heavily on the notion that its citizens know how to use and manage technology effectively. Do we really desire to create two societies—one that is technologically literate and the other one, which is not?

I believe not. Most colleagues with whom I discuss this problem seem just as puzzled about it as me. The sparse participation of minorities in our profession and in our school programs is not an indictment against anyone in our field. The position we find ourselves in has evolved over time and certainly is symptomatic of our nation's larger problems with urban schooling and is partially the result of urban flight (our attempts to escape the cities by moving to the suburbs).

Where are our minority teachers? Again, one could argue that the field is replete with minority technology education teachers, both at the elementary and secondary levels and even at the college level. However, a casual observation of the participants at our annual conferences suggests that minority participation is very limited. Further, this is validated in this author's home state (Ohio) where minority participation seems to mirror the national trend.

The same trends can be observed at our technology teacher training institutions. For example, at historically black institutions, the number of minority faculty is small with a significant part of that faculty participating in industrial/engineering technology programs in lieu of technology teacher education programs. At historically non-minority institutions, there is only a handful of minority faculty.

It seems clear that we have an overall national problem of attracting minorities to the field of technology education. Lest we feel too bad about the problem, however, as it seems to be a problem in education in general. But that should not let us off the hook.

Both minority and non-minority students need positive role models which represent the diversity of our country. Therefore, the problem is compounded by the fact that we need to recruit teachers who are capable of functioning effectively in both urban and suburban environments. Furthermore, the way we prepare teachers must change in order to accommodate the diverse needs of teachers who may be working in either environment.

We must make the issue of the lack of participation of minority persons (teachers and students) in technology education a matter of strategic importance. Aggressive efforts need to be undertaken now to design strategies for convincing our public of the importance of technology education for All Americans. Such efforts need not detract from the many fine efforts already in place in suburban schools. In fact, these programs should be used as models while developing convincing arguments for equity and access to members of urban school's boards of education and other decision-makers. At the state legislative level, arguments should be made to ensure that technology education is a required subject. Research should be undertaken that demonstrates the importance of technology education in helping to attain skills in mathematics, science, social studies, and reading.

Concurrently, efforts should be undertaken to identify potential leaders in technology education who are persons of color. These individuals should be nurtured with leadership skill training and commitments to be involved in key offices and committees of organizations such as the ITEA and its various state and local affiliates. The Technology Student Association (TSA) should continue to recruit minority students for leadership roles in its organization. If there are distinguished minority teachers and excellent programs in urban areas, then it's incumbent upon us to identify and nominate them for program and teacher-of-the-year recognitions.

Colleges and universities should combine efforts and work together (instead of against each other) in the recruitment and retention of minority teachers. An example would be for undergraduate industrial technology programs to work with post-baccalaureate certification programs to train minority teachers. Cooperative efforts with two-year technical schools, community colleges, and the military (all of which have large numbers of minorities) ought to be explored.

Technology for Some Americans? I hope not. Technology education has a rich history of serving all students. Since the turn of the century, the precursors to technology education have served students in urban environments well. When most of us lived on farms in this country, we learned naturally from family members about the use of tools, materials, and processes to solve technological problems. The one-room schoolhouse was generally reserved for teaching reading, writing, and arithmetic. When we moved to urban areas after the Industrial Revolution, children no longer learned practical or technological skills in naturalistic environments. Thus, the need to teach manual arts and industrial arts as an organized school subject became paramount. From that time until approximately the mid-1970s, industrial arts experienced much growth in our urban schools. Almost all urban children were exposed to industrial arts/technology education programs.

Of late, unfortunately, a disturbing trend has emerged. Technology education is enjoying much growth and development in mostly suburban schools while facing a decline or elimination in many of our urban cities. It seems clear that some children are being denied opportunities to participate in technology education. If we choose to do nothing about these issues, then we must be prepared to answer the following questions:

1. What are the consequences to our country if some Americans are given access to technology education while others are denied such opportunities?
2. If our field portrays an image of not serving persons of color, how will people on the outside view our field?

I challenge all people at all levels of technology education to give special attention to the issues I have raised in this essay. It is important that the lack of minority participation be placed in a position of high prominence on our 21st century agenda. Nothing less is acceptable—nor should it be.

Essay 33

Do We Teach Technology? Yes, But We Also Teach Kids!

Richard D. Seymour
Ball State University
Muncie, Indiana

Most of us teach technology courses on a regular basis. We cover production topics, or teach about design, or evaluate technological impacts in our various classes. We run laboratory activities and show videotapes and grade homework. As technology educators, we spend a lot of time on computers and routinely fix machinery in our laboratories.

This scenario sounds like a characterization of a typical technology teacher—doesn't it? The daily agenda varies little from the intended lesson or planned activity. If a flow chart was established, one might identify steps such as planning instruction, organizing content and activities, introducing assignments, running the activities, summarizing each topic, and evaluating student progress towards achieving outcomes. All very clean—all right out of a collegiate methods textbook.

Of course, this view of the teaching profession, and of technology education in general, is not so simple in this age of change. Today's society is different from those of past decades, and so are the individuals who show up every day for our classes—our students. Schools have taken on new challenges, from dealing with troublesome behaviors to providing social services. Technology teachers must learn to function in this complex, often turbulent environment that is so prevalent today.

As teachers and managers of education, we often get lost in the daily routine of classroom instruction, curriculum issues, and extracurricular assignments. We forget we are teachers of young learners first, and professional technology educators second. This applies to us equally on a personal and school level. Mulgan (1997) noted that one center for Clinical Infant Programs reported that "the seven most critical qualities that children needed in order to do well at school included: confidence, curiosity, intentionally (the wish to have an impact), self-control, relatedness, the capacity to communicate, and cooperativeness. Most, in other words, turned out to be social skills, skills of managing connections" (p. 140). Sure, teaching about technology is important, but we must also focus on the youngsters in our technology classes.

Numerous educational studies describe the changing social and cultural demographics in today's schools. These reports cite the growing number of at risk students including those who are exposed prenatally to drugs or alcohol, those who are exposed to abuse at home, or still others who go to bed hungry night-after-night. Children from impoverished communities, plus single or no parent homes, are also considered at risk by several authors. Students in these situations face problems with social relationships as well as substantial learning difficulties. For instance, research clearly suggests that poor communication skills and impulsivity are associated with fetal alcohol exposure in children (Stevens & Price, 1992).

Unfortunately, this diverse population of learners is showing up at schools that are set up on the industrial-age model of education. The school day is fairly rigid, with most instructors teaching at least five classes each day. There is little opportunity in a standard 45-50 minute class period to give individual attention to the dozens of students that attend classes. It's perhaps understandable that teachers use a "fixed, predetermined curricula, with no allowances for situational modification" (Noblit, Rogers, & McCadden, p. 681) in surviving the daily demands of instruction and classroom supervision.

As technology educators, most of us have experienced a diverse group of students in our classes. At one end of the social spectrum are the computer nerds that excel at hands-on applications, yet often have limited personal skills. On the other hand, many students are routinely assigned to technology classes because school personnel consider the area a dumping ground for troubled students. Delinquent and challenged learners are routinely assigned to elective courses (especially the hands-on programs in the technology area). This assortment of personalities and backgrounds makes it challenging to work effectively with more than a few students in any single class period.

Yet to be mentioned are the personal difficulties or tragedies that mar the life of children today. With the teenage suicide rate climbing and the abuse of drugs and alcohol by youngsters increasing, almost everyone can identify someone who has faced a life-changing crisis at an early age. Crime, violence, and adult situations are all too normal in today's society. As a result, teachers interact directly with many emotional and bewildered students on a daily basis.

Berliner and Biddle (1995) remind us "that American schools must be prepared to help a lot more educationally disadvantaged students over the next few years" (p. 277). At risk populations, students from varying cultures, or simply the number of youngsters trying to cope with a personal dilemma will continue to increase in our secondary schools. Baring a major overhaul in the structure of schooling, educators must strive to build better relationships with their students within the existing constraints of the curriculum and daily agenda. The importance of a caring and supportive classroom is reflected in Noblit's et al. (1995) observation that "no one can reach his or her full potential without social skills, a feeling of self-worth, strong academic and cognitive activities, and nurturance and support" (p. 683).

Technology teachers need to address the specific needs, concerns, desires, and social skills of all students. It's not an option that we simply work on curriculum all the time, yet ignore the human beings that enroll in our classes. As the 1991 SCANS report noted, technological content and process are important, but so are the development of personal characteristics and foundational skills.

Educators, and technology teachers in particular, tend to blame the problems associated with modern schooling on the inputs, or the students who enroll in their classes. We need to stop complaining about negative trends or conditions and focus on deficiencies of the school system (especially those related to the needs and issues of our students). Technology teachers must foster a supportive and caring philosophy that includes all students. Noblit et al. (1995) observed that "caring fosters this teacher/student connection and encourages possibilities for learning that may not otherwise occur" (p. 683).

It is fairly easy to implement lessons that promote academic understanding and personal development. For example, a cooperative spirit is enhanced when group (or team) problem solving activities are used in addressing specific opportunities. A sense of community is established when activities focus on local needs and issues like designing a park for an impoverished neighborhood or creating a recycling program for the school. Students might better understand the challenges facing the wheelchair bound if assigned to create an accessibility plan for an existing structure. Sometimes student development comes about in creative ways, such as through a student club activity or service project. Numerous examples of laboratory activities based on human wants and needs are found in technology textbooks, in state or provincial guides, or on the Internet.

Mulgan (1997) suggested that "a curriculum fit for a more connected world would place a much greater emphasis on relationships" (p. 143). This concept is true of both personal and systems level associations. Due to the increasing complexity of technologies, most modern ventures require a team effort. Whether it's a flight crew or a product development team in a Fortune 500 company, both must function within the constraints of a global scenario. Even teaching in a technology education program demands new group skills and knowledge of evolving practices in order to succeed in the changing school environment.

In another example of interrelationships, our global information networks provide routine communication with others. Students also have access to digital scanners, color reproduction equipment, and audio equipment. Knowledge may be shared and gained more easily than ever before in our history, yet this same media that permits an open exchange of text and images requires cultural sensitivity and restraint. Technology educators must make it clear what is admirable versus unacceptable. Gerstner, Semerad, Doyle, and Johnston (1994) stated that "just as schools cannot run if students are not well-behaved, students cannot succeed in school—or life—

if they fail to learn habits of self-restraint, forbearance, and delayed gratification. . . . skills and values as basic as learning to count or to speak English" (p. 193).

Today's schools and educational practices have made teaching a complex, yet often casual task devoid of student attention. This is especially true in technology programs where an evolving curriculum has become the prime focus over the past decade. Little time has been spent learning about the students who show up in our classes on a daily basis, including a focus on their questions and their strengths and needs. Unfortunately, more often than not, academic growth (or progress) has been measured solely by answers to cognitive responses on examinations.

Sure, we teach our subject matter in an exciting, hands-on manner. And yes, we provide a laboratory full of new equipment and materials. But we also teach youngsters that are curious, eager to learn and grow, and uncertain about their technological world. We must spend time learning about them, addressing personal and social needs as well as the demands of the curriculum. Our attention to the learner deserves a position of prominence and importance on technology education's 21st century agenda. Don't you agree?

REFERENCES

Berliner, D. C. & Biddle, B. J. (1995). *The manufactured crisis: Myths, fraud, and the attack on America's public schools.* Reading, MA: Addison-Wesley.

Gerstner, L. V. Jr., Semerad, R. D. Doyle, D. P., & Johnston, W.B. (1994). *Reinventing education: Entrepreneurship in America's public schools.* New York, NY: Dutton Group.

Mulgan, G. (1997). *Connexity: How to live in a connected world.* London, UK: Chatto & Windus.

Noblit, G. W., Rogers, D. L., & McCadden, B. M. (1995, May). In the meantime, the possibilities of caring. *Phi Delta Kappan, 76*(9), 680-685.

Stevens, L. J. & Price, M. (1992, September). Meeting the challenge of educating children at risk. *Phi Delta Kappan, 74*(1), 18-23.

Essay 34

Concepts in Technology: Seeing the Order in the Chaos

Marc J. de Vries
Eindhoven University of Technology
Eindhoven, The Netherlands

The speed of technological development is so rapid that what is new today will be old fashioned tomorrow. Technology education textbooks, for example, that are based on individual technical products without teaching basic concepts, will be outdated within a few years of their publication date. It is almost impossible to keep textbooks up-to-date if one really wants to have the newest gadgets included in them. Yet, we do want to prepare our pupils to live in today's technological world, not yesterday's. In fact, we also want them to be able to live in tomorrow's technological world. But a fundamental question remains. If it is so difficult to keep track of current technologies, how can we ever write a textbook that contains tomorrow's technical products and processes? So far, I have mentioned just textbooks—but that is only one of the many teaching and learning resources. In fact, the textbook dilemma I have described holds true for whatever other resources that might be available to technology educators.

Some technology educators feel that in the high tech era of today, it is appropriate to throw away everything related to shop facilities. Unfortunately, even before the 21st century arrives, these same educators will have found their new technologies to be obsolete. Does that mean that shop was okay after all? That is questionable. One of the main motives for introducing high tech stuff was the recognition that teaching technology by making pupils skilled craft workers was not exactly meeting the demands of modern society.

What happens if the traditional shop and high tech approaches do not guarantee a relevant school subject that will prepare people to make sophisticated decisions about technology? Of course, there is no single and unique answer to that question. It is a question, however, that technology educators must continue to address. Whether we are able to teach the basic concepts of technology that remain constant over time, even though their appearance in concrete applications may change, will be important. Some technology educators even accept this point to be the main basis for defending technology education as a separate subject in the school curriculum. I will deal with that debate here as I think there are additional motives for defending that position. If one could defend that technology is a discipline in its own right and with its own body of knowledge, it does not necessarily mean that it should be taught as such. No, even separate from this whole debate about whether or not technology should have a separate place in the curriculum because of its unique body of knowledge, the quest for basic concepts remains.

How do we justify technology education on a conceptual basis? I think there are three questions that need to be answered. First, what are the basic concepts? Second, to what extent do pupils already recognize these concepts or may have entirely other preconcepts in mind when they enter our lessons? Third, how can we create teaching and learning situations that enable pupils to adapt their mental concepts so they will be in accordance with real world technological concepts? Let's consider these questions individually.

When science educators search for basic concepts for teaching science, they go to university faculty who are regarded as an academic analog of the school subject. The same holds true for all types of other subjects, but not for technology education. Of course, one could think of the various engineering disciplines, but who would like technology education to be the sum of all those disciplines? Another option that needs to be considered is the philosophy and history of technology. Philosophers and historians have provided a lot of information about the nature of technology, but they are very much in the development stages in putting this information together. Still, it is worth establishing contacts between technology educators and philosophers and historians of technology. My own position is somewhat of an intermediary as I have been involved in technology teacher training for several years. I now find my current research position in the philosophy and history of technology most fruitful for the technology education activities that I continued to develop after I took up my new position. Gradually, I began to see the richness of concepts that related to the nature of technology. This is much more than the concept of systems that by now most technology educators have recognized as basic. In the textbook, *Techno-logisch* (Dutch for technological, i.e., there is a logic and order in technology and it is not merely a chaotic collection of a thousand-and-one devices), my colleagues and I tried to help pupils recognize the order in the chaos by focusing on these types of concepts.

When considering the issue of pupils' pre-concepts, I think technology educators should really be jealous of science educators. Science educators have already established research outcomes to determine what ideas pupils already possess about our subject matter. These ideas match closely with what we consider to be truth from an academic point of view. There is no need to tell pupils what they already understand and it does not make sense to assume an understanding they do not yet possess. The Pupils' Attitude Towards Technology research that Jan Raat and I initiated years ago was a beginning for this type of research. Recent surveys by Karen Zuga at The Ohio State University and others have shown that in the United States there are still very few studies of this type.

Our challenge for the 21st century is to establish a research base similar to that which science educators have established. The research base will inform us of the type of thinking we can expect our pupils to work with when they go through our technology education programs. Once we have the knowledge, we can more effectively extend the scope of the pupils' concepts of technology from products only to all four of Mitcham's (1994) categories of products, knowledge, processes, and volition.

Lastly, there is the question of how we can change pupils' preconcepts to become more in line with what we would like them to think from an academic point of view. Change requires teaching and learning situations that take into account the answers to the previous two questions. We have lots of experience with making workpieces and we are quite fast in gaining experience in doing project work with our pupils. But how do we create a totality of practical and theoretical activities that enables concepts to grow in a natural and gradual way in the pupils' minds? Sound research studies would help a great deal—maybe just by collecting successful examples and then trying to dig out the secret of their success in terms of the way they have dealt with technological concepts. One point of particular relevance is that general concepts and skills can never be taught or learned in a vacuum, but only in connection with concrete situations. In other words, we cannot teach pupils general problem solving skills by making them solve general problems. We can teach them to solve all types of specific problems but it is questionable if solving one problem will automatically provide insights and skills for solving the next problem. The same holds true for general concepts. Recognizing a car as being a system may not automatically enable pupils to recognize the television set as a system also. We need well thought out educational situations in which pupils learn to make that type of transfer.

In summary, the 21st century agenda for technology education must address three topics: (1) We need to work with technology philosophers and historians to learn more about their ideas of what is the nature of technology and with what concepts technologists work. (2) We need to collect more knowledge about the extent to which pupils do or do not hold awareness of the basic concepts of technology. (3) We need to be creative in finding which teaching and learning situations we can shape that will enable pupils to adapt their own ideas to what we would like them to believe. If we are willing to address these three challenges, pupils will start to recognize the order in the seemingly chaotic variety of technical objects and issues. They also will be able to understand not only yesterday's and today's technologies, but also tomorrow's technologies.

REFERENCES

Mes, P., Smeets, J. & Vries, M. J. de (1998). *Techno-logisch* (2nd ed.). Houten: EPN Publishers.

Mitcham, C. (1994). *Thinking through technology. The path between engineering and philosophy.* Chicago/London: University of Chicago Press.

Vries, M. J. de & Tamir, A. (Eds.) (1997). *Shaping concepts of technology. From philosophical perspectives to mental images.* Dordrecht: Kluwer Academic.

Essay 35

Pursuing Profound Understandings in Technology

Kenneth Welty
University of Wisconsin-Stout
Menomonie, Wisconsin

There is nothing like an in-service workshop to uncover the passions of technology educators. For many veterans of public education, these gatherings break the routine and isolation that plague their work life and provide unique opportunities for exchanging ideas with colleagues. The divergent points of view and the healthy debates that emerge during these sessions challenge everyone's assumptions about what they believe is worth teaching and learning.

Over the past 16 years, the author has talked to thousands of technology teachers while conducting or attending almost 100 teacher in-service workshops. Many of these meetings became very rich and spirited when the message being conveyed from the podium conflicted with the audience's ideas about what is affectionately referred to as *the basics.* While the technology education movement has inspired some leaders to promote the study of contemporary technologies like computer-aided design, alternative energy systems, and geodesic domes, seasoned classroom practitioners have often been compelled to defend the need to teach students the types and sizes of wood screws and nails, the anatomy of a house, and how to grind a lathe bit. To the impartial observer, both perspectives are presented with passion and dedication in the interest of improving public education. However, these meetings also generated unsettling questions about the relative value of the content we aspire to teach and what students need to learn under the auspices of the basics.

The lack of consensus surrounding our knowledge base has spawned divergent perspectives regarding what is commonly referred to as the basics. To some, the basics are specific technical details like the types and sizes of wood screws and nails. The assumption here is mastery of specific details is the most logical place to begin building an understanding of technology as well as a capability to use technology to solve problems. Critics of this perspective are quick to point out that this kind of knowledge borders on technical trivia and a reasonably intelligent person can gather and assimilate these details if there is a genuine need for this kind of information. On the other hand, supporters of this perspective may argue that attention to this kind of detail provides the student a basic foundation on which other understandings and skills can be developed.

A review of the professional literature would suggest that teachers should temper the attention given to technical details in favor of contemporary and emerging technologies like computer-aided design and manufacturing. One of the assumptions underlying this perspective is students need to prepare for the future by studying the technologies that will be an integral part of our technological infrastructure in the 21st century. Students can be seen reading manuals, entering codes, and executing programs in schools that have adopted this school of thought. However, one can not help but question if learning the commands and procedures associated with a given CAD/CAM system will serve students in everyday life any better than knowing the types and sizes of wood screws and nails. Ironically, critics of this perspective may argue that students are far more likely to need to select an appropriate mechanical fastener in their local hardware store for a household task than they are to define the tool path for an automated milling machine.

Structuring the curriculum around contemporary topics like computer-aided manufacturing, alternative energy systems, and geodesic domes has resulted in teaching content that is just as removed from the everyday lives of students as woodworking and metalworking. Our attempts to enrich the curriculum by addressing more contemporary topics have caused some teachers to simply exchange one body of specific details for another. Instead of memorizing the types and sizes of nails and screws, students are trying to discriminate between direct gain, indirect gain, and isolate gain passive solar energy systems. In other cases, teachers have simply rejected the content being proposed by leaders because it lacks practical application in everyday life and the world of work.

One of the most pressing challenges facing the technology education community as we plan for the 21st century is the need to develop a knowledge base that honors the traditions of the discipline and captures the understanding that will prepare students for an uncertain future. Conscientious technology teachers are striving to design and deliver programs that address the breadth, depth, and diversity of technological knowledge within a K-12 curriculum. However, given the rapid growth in technological capability, it is becoming increasingly difficult to believe these programs can prepare a new generation of citizens that have a mastery of a knowledge base that is expanding at an exponential rate.

In contrast to filling the curriculum full of technical details, the technology education community needs to uncover a modest, yet seemingly elusive, collection of profound understandings and empowering skills that capture the essence of technology. For example, instead of simply teaching students the anatomy of a house (e.g., sills, band joists, sole plates, trimmers, jack studs, cripples, headers, top plates), one would target the essence of construction by emphasizing why people build things the way they do. More specifically, the content would concentrate on the idea that people erect structures in ways that define space, carry and distribute weight, accommodate utility systems, and enable materials to be fastened together. If teaching the basics means focusing on the parts of a house and the function they serve, then all that students will really know about construction is the anatomy of a house. However, if the teacher stresses more transferable concepts like tension and compression within and among structural members, students will possess a conceptual base for understanding how skyscrapers, office buildings, warehouses, and geodesic domes are constructed.

After years of reflection, this author has come to believe the basics are the concepts and skills that are common to a wide range of technologies. In contrast to being a collection of specific details, the basics are profound understandings about technology that can be used to understand a variety of technological devices, systems, and processes. According to this perspective, the basics are the intellectual building blocks used to develop new technologies and, inversely, can be used to breakdown complex systems into their simplest form so they can be understood.

Identifying these profound understandings involves seeing the big picture, searching out the essence of technology, and formulating generalizations that enable students to make sense out of the technology in their world. If teachers adopt profound understandings as their basics, the goal of instruction is to help students develop a conceptual knowledge base and the thinking skills necessary for a lifetime of building new understandings without concentrating on unnecessary details.

In defense of those who support teaching specific details, it would be extremely difficult for students to formulate generalizations about technology without some attention being given to details. However, it is equally difficult to imagine students formulating these generalizations if the curriculum is saturated with details. Therefore, in contrast to being the core of the curriculum, technical details should be used as pedagogical tools for building profound understandings in the mind of the learner.

Under the existing paradigm, students are learning how to identify specific types and sizes of wood screws and nails for the sake of being able to recognize these mechanical fasteners. This approach generally warrants a clear set of transparencies and series of examples to present the content to the students. The students, in turn, need to note the differences between each fastener, attach the appropriate name to each variation, and commit the collection to memory. Under the guidance of a talented teacher, presenting each fastener in the context of an application that is consistent with the interests and experiences of the learner would enrich the learning process.

Instead of targeting the nomenclature associated with nails and screws, suppose the same lesson was designed to help students recognize that the holding power of a given mechanical fastener is dependent on the amount of surface area that comes in contact with the material being joined. This approach would require experiencing a variety of mechanical fasteners, testing and noting the holding power of each, and formulating a generalization based on the salient features of each fastener in relation to its holding power. Furthermore, students would need to be provided opportunities to test and validate their generalization by applying it to a new and unfamiliar fastener. The desired outcome of this lesson would be students who can reason for themselves why washers often accompany rivets, when screws are more desirable than nails, and how a staple can hold soft materials better than a nail of equal weight. However, in striking contrast to the previous scenario, there is a good chance these students would not know the technical name for a given fastener without consulting the label on its original package.

As we plan our agenda for the 21st century, we must have the courage to ask ourselves very difficult questions. Does all knowledge have equal value in the lives of students preparing for life in the 21st century? Are there profound understandings that will empower students to make sense out of technologies that have not even been developed? How do we go about uncovering these profound understandings that capture the essence of numerous technologies, both old and new? What kinds of strategies should we employ to enable young people to construct these understandings for themselves?

As the knowledge base for technology continues to expand at an exponential rate, the need to discriminate between trivial facts and transferable understandings will increase. It is futile for the technology education community to believe it can address both the breadth and depth of technological knowledge within a K-12 curriculum. Furthermore, it can not afford to allow the entropy within the current curriculum to go unchecked as we enter the 21st century. Therefore, we must identify a manageable set of understandings and skills that will empower young people to make sense of the technologies that will sustain their quality of life in the 21st century.

Essay 36

Technology with a Human Face

Robert C. Wicklein
The University of Georgia
Athens, Georgia

The major thrust of technology education or at least a major thrust is to instruct students on the processes needed to solve technological problems. When we implement this particular thrust in the classroom, we often focus a majority of our instructional time on the use and application of a few high tech gadgets (e.g., robots, CAD, and CNC). We then conclude that somehow this helps our students become technological problem solvers and technologically literate. This approach may be particularly interesting to teachers. However, it doesn't significantly help our students develop the thinking skills needed to solve problems within the broad field of technological applications. By focusing our instruction on specific technical applications and procedures, we often limit the beneficial results of our field of study.

The field of technology education must heal itself from this myopic condition and see the world in a broader way if it is to be a significant participant in the educational arena in the 21st century. The majority of real world technological problems and their plausible solutions do not require complicated high tech applications. The technological problems that most of us face on a day-to-day basis are best solved by employing much lower levels of technology than what is currently being presented in technology education. This is especially true for the majority of people from nonindustrialized countries. Approximately 80% of the earth's population live and work in environments where high tech solutions would be inappropriate when solving technological problems. Therefore, the need exists for technology education to address technological problem solving from a more holistic and appropriate level—that is, less high tech, more thoughtful problem solving using available resources.

You may ask, what would this form of technology education really look like? What would be different about this curriculum than what is currently being used? What would be the benefit of this type of program for students and the profession? I suggest the following for your consideration. This form of technology study would lend itself in helping students learn to analyze and solve problems within a more realistic context. Starting with their own school and community and then progressively moving out to the state, region, nation, and world, students would benefit by developing a focus on learning that reflects the application of appropriate technological solutions within a problem solving environment that directly affects them. Examples of benefits to students include addressing environmental recycling within their own school, planning and designing recreational facilities for their school or community, and designing a special effects scene for a school play would be typical applications. The difference this form of technology education takes is that students are given more of an opportunity to be creative, to think logically, and to act responsibly as they work to solve problems that are important and intrinsic to them. The use and application of tools and other technological devices within this context are studied and used as they apply, rather than in a narrowly defined context of unconnected tool applications.

The problem solving opportunities can also move beyond a local condition (e.g., planning recreational facilities) to address problems or opportunities that go beyond the boundaries of the school, community, or even the state and nation. By continuing to focus the student on broader topics that are based in reality and are important for humanity, the learner is able to grow and develop as a human being and better understand that he or she can make a difference in the world. This form of technology education would be uniquely different from existing models, as students would begin to see themselves as part of a solution in helping humanity. They would begin to understand how technology fits into the overall plan of creating a better world for everyone and how they can be a part of the solution, not just an observer that has little control or influence in the overall scheme of things.

The learning contexts associated with appropriate technology and problem solving are critical to both framing important technological and scientific concepts and enlightening students as to everyday meaning of erstwhile inert knowledge. In this approach, the learning is situated in the context of a global concern or issue, students work toward solutions based on criteria that are pertinent to a given situation (e.g., problem scenarios embedded in real world conditions and environments; social/cultural factors integrated as part of the problems). One way of situating this concept for students is to use current news stories into which key technological concepts could be anchored. For example, contexts can be selectively induced or extracted to amplify circumstances where technology has been associated with dire consequences such as the influence of clear-cutting Brazilian forests on soil erosion and air quality or, following a flood in Honduras, drinking contaminated water. This format may stimulate students to engage in real world events and employ technological problem solving to develop plausible conclusions where there is not a clear-cut answer. Through these types of learning environments, students become immersed in research, analysis, exploration, manipulation, and informed experimentation to provide workable solutions. At the same time, they become aware of people and places that they may never have been aware of before.

The potential impact of this approach to technology education could be profound. First, it would be a radical departure from current practices of piecemeal exposures to selected technologies while focusing on real world situations where appropriate forms of technology will be learned and employed to solve problems. A primary goal of this form of technology education will be on understanding real world environments and determining plausible solutions while considering the impacts on people. Students and teachers would be required to consider a variety of human conditions and developmental criteria in designing and developing appropriate solutions to problems. Second, this approach would require that students and teachers begin to address human conditions outside of the typical school classroom. As this approach is developed over the course of a school term, students have opportunities to experience how people from diverse backgrounds around their communities, across the nation, and around the globe could benefit from appropriate technological solutions. In short, this is a much more comprehensive approach to knowing and doing technology education—it's technology with a human face. The consequences for not considering this form of technology education will be the continuation of the status quo.

As we enter the 21st century, radical changes will continue to take place in the forms and uses of technology. Our current practice of picking and choosing a few types of high technologies to study and experience may impress school administrators and politicians. However, the educational effect on students will be minimal, leading to a very skewed perspective of what technology is and what it can do. The end result will continue to be unreflective students with minimal real problem solving skills.

If we are serious about our instructional content and if we want to prepare students for the future, then we must help them to see how technology can be used to solve problems in realistic ways. Our planet needs more thoughtful humans that care deeply and can think and solve problems appropriately. Technology with a human face, therefore, must be on technology education's 21st century agenda.

Essay 37

Technology Education as an Integrator of Science and Mathematics

Karen F. Zuga
The Ohio State University
Columbus, Ohio

About five years ago, our dean declared that no single program in our college would be able to continue to exist without forming partnerships with other teacher education programs. In this way we were thrust into restructuring, a business trend that had finally hit campus. After an elaborate year of courtship, we settled down to form a relationship with the colleagues we believed would be our most logical partners in teacher education, those faculty who certify science and mathematics teachers.

In contradiction to the commonly accepted and historical pairing of vocational, technical, and human resource development educators (industrial educators) with technology educators in programs preparing people to teach, our faculty believe that there are few pedagogical ideas and principles, other than educational setting, that technology educators have in common with industrial educators. The main goal for technology education has always been to educate all children about technology, not for acquisition of job skills, but liberally, to form a basic knowledge and understanding of how humans create and use technology and technological systems. In this goal, we see compatibility with the pedagogical activity of science and mathematics teacher educators and diametric opposition to the job preparation goals of most other types of industrial educators.

During our restructuring efforts we began a dance, ostensibly to restructure our separate teacher education programs into one program for certification in science, mathematics, and technology education. But, as with most romances and eventual marriages, we found out that we really had to learn more about each other, and much of our work and time had been devoted to doing just that as we began to team teach pedagogical courses. We needed to find and, to some extent, still need to find a common understanding upon which to base our integration. (It always amazes me how little we know about our teacher education colleagues' professional interests and specialties.) Having taught three combined cohorts of students several courses dealing with integration, I want to offer, based upon my experience and knowledge, a basis for integrating science, mathematics, and technology education in schools and in teacher education programs.

Our first attempt to create integration was to focus on the curriculum content in order to integrate it into a new structure. I am convinced that this idea is not viable. Integrating three separately constructed content structures based upon fundamental differences such as concepts and processes is a complex problem, testified to by the frustrating experiences of our faculty through several seminars dedicated to this effort. Moreover, the value placed upon structuring of disciplines continues to diminish in contemporary education and society as philosophy changes and new fields of study such as biotechnology emerge at the intersections of existing disciplines. These emerging fields of study contribute to the need for continual restructuring of the disciplines to the point of questioning the value of structures.

Instead of content integration, the integration of the three subjects does revolve around the pedagogical theory and principles of contructivism as the effort to facilitate students' construction of their knowledge of the world in situated learning contexts, or practical application. Science, mathematics, and technology education, as well as other subjects, merge with technology, as application, being the situated context. This proposal unifies the separate efforts in each subject matter to focus on higher order thinking and learning expressed through the implementation of constructivism in science and mathematics education and technological problem solving in technology education. Technology educators can provide the context for the application of science and mathematics.

Focusing integration through pedagogy does not deny a specific content base to technology education or to science and mathematics, it is merely a proposition that the integration of the subjects is not about content, but it is about pedagogy, educational theory and methods. To teach about technology well, we must teach students about scientific principles and mathematics concepts. To teach science and mathematics as constructivists, the situated context can be provided by the applications possible through technology and technology education laboratories.

To some technology educators, the idea of integration has been problematic in that there is a fear of losing one's identity, of being subsumed by science and mathematics educators. This proposal may rekindle those fears with the added fear of becoming cast in the role of method rather than content in the curriculum. Foremost, the efforts to refine technology education curriculum as a reflection of the state of the art with respect to technology should continue, and continue through the efforts of technology educators who have dedicated their professional lives to this task. The continual refinement of the subject as an effort to teach about how people make and do things in an organized and systematic fashion promotes the growth of the field of study. Science and mathematics educators are specialists in science and mathematics, not technology education. Current exhortations and attempts in science education to teach about technology appear to be infrequent and often ineffective (Freedman, 1998). Science educators have a very large mission in the effort to teach science well, utilizing contemporary theories and methods. In mathematics education efforts to teach about technology are often limited to calculator and computer applications, logically, because of the role this kind of equipment plays in the conduct of mathematics. Except for the stray engineer who enters these compatible teaching careers, for the most part, both science and mathematics teachers and teacher educators are not prepared to teach about technology.

I propose a collaboration of science, mathematics, and technology educators through integration as a solution to the problem of teaching all children about technology. If we are going to answer the charge to teach all children about technology (Freedman, 1998), then, technology educators need to assert, confidently, their knowledge, experience, and role in that effort. In that act, technology educators will establish themselves as those who provide the context for situated learning. In this way, technology educators will contribute to improving education for all children.

For technology educators there is no other path. To try to remain separate from our colleagues in other subject matters leaves us where we sit today with the public assuming that science educators are teaching about technology, or worse, that science and technology are the same thing; with a few of our children learning about technology in isolated laboratories not used by the entire school population; with our colleagues in schools and on campus unaware of who we are and what we do; and with far too few resources and teachers to even introduce children to ways of thinking and learning about technology. Integrating technology education with other school subjects is one of the quickest and best ways to address the ever growing need for children to learn about technology. And, integrating does not preclude maintaining existing technology education programs, nor should it.

Integrating science, mathematics, and technology education makes sense, educationally and practically. It is a winning situation for all concerned. Students gain exposure to an organized and established body of knowledge about technology and at the same time can explore the relationships of scientific constructs and mathematics principles in a realistic context through technology education laboratory activities. In a technology education laboratory, including the scientific constructs and mathematical principles which relate to technology education content and activities strengthens the connections that students can make in all three subjects and in their integration. There are already some excellent materials, generated by technology educators working in collaboration with science and mathematics educators, which accomplish these goals. Traditional technology education activities such as the egg drop, mousetrap car, and bridge building and testing are excellent examples of activities which provide for the situated learning context.

The technology educators on our campus were faced with a situation of collaborating or perishing. Many technology educators are facing similar circumstances in schools. Given the choice of collaboration or struggling, alone, for survival, what would you do?

REFERENCE

Freedman, D. (1998, Fall). Science education: How curriculum and instruction are evolving. *Curriculum Update,* 1-3+.

Unit IV

A CALL TO ACTION

Essay 38

The New Millennium: A Time for Change

G. Eugene Martin
Southwest Texas State University
San Marcos, Texas

Don't be too quick in drawing conclusions about what you think you are going to read in this essay. It is not my goal to be so presumptuous or even to imply that I might have all the answers to the critical questions facing our profession for the new millennium. However, I do want this essay to convey that change, purposeful change, is dearly needed—now more than ever before—if our profession is to be a significant player in the educational arena during the 21st century. The time for change is now and change will require a total team effort.

While there are many topics we need to address to bring about purposeful change, I do believe there is a core of topics where we should be focusing our energies during the first few years of the new millennium. However, please do not accept the topics I identify as being prescriptive or even all-inclusive, as that is not my intent. The topics are presented as food for thought, to hopefully cause you to make a commitment to change, to encourage you to yearn for a new beginning, and to cause you to want to become more proactive not only for your personal professional well being, but for the technology education profession as well. I encourage you to add to my selected list of topics as you deliberate the need to make a personal commitment to change.

In the new millennium, technology education will be no stronger than the commitment of the people who choose to call themselves technology educators. The key word is commitment. We need a stronger personal and professional commitment and we need to obtain and exhibit that commitment now. We also need an equally strong commitment from people who make decisions about the role and scope of technology education in a formal school setting. Included in this list of people are college presidents and provosts, college deans, school superintendents and principals, state and local supervisors, and school board members. But the list goes on and on. We need to double our efforts to make sure the key decision-makers understand and actively support our field. We also need to speak as one voice with a common mission and vision. Some states are clearly at the forefront in their positive and active influence on key decision-makers but unfortunately, many states are still lagging behind. At the same time, the International Technology Education Association continues to build strong alliances with key decision-makers at the national level. One very important example of their efforts is the interdisciplinary relationships that have been nurtured with the math and science communities. Alliances such as these must continue to be built and maintained from the grass roots to the national level. A strong positive influence will require a team effort of all the stakeholders to address the critical issues facing our profession. The time for change is now.

As you ponder the urgency for change, accept that the development and nurturing of technological literacy in every person is the very reason why we exist in a formal school setting. Technological literacy gives our profession its competitive edge. We need to stop arguing about what technological literacy is or is not and accept the work of the Technology for All Americans project as the definitive piece of work on this topic—and then get on with the core topics at hand. Let's determine where we belong along the continuum to preparing technologically literate people and then develop the alliances we need to become a successful and much sought after school program. Developing and implementing standards is a start, but not the total answer. Individually and as a team, let's engage in visioning, goal setting, continuous learning, and a commitment to excellence while focusing our energies on developing and being problem solvers, critical thinkers, and change agents. The time for change is now.

We need more people who want to be leaders just as we need more people who want to be followers. We also need people who are committed to being mentors if we are truly committed to bringing about change. As a team, let's address our public image and let's get help in marketing our product. I submit our product is technologically literate people who possess the ability to use, manage, and understand technology. The time for change is now.

During the early part of the new millennium, more people will be entering the teaching profession than entered it in the 1990s. Start thinking outside the sphere of our past practices in how we recruited people to become technology educators. Get creative in how we might get a commitment from this new population that is entering the teaching profession and get equally creative in how we might retain this population once they make a commitment to being technology educators. Just a cursory view of the changing demographics in the United States leads one to readily conclude that we should focus considerable energies on cultural diversity as we develop and implement plans to recruit and retain technology educators. A continuation of a white male dominated technology education profession will not work in the new millennium and it should not work. A good place to start, but not the only place, is to critically examine how we pre-service and in-service our professionals. Are there better ways to certify future teachers than we employ today? I think so. We need to learn from the success stories in other disciplines, and then take the best from them and implement successful strategies for our profession. The time for change is now.

We need to tear down the traditional barriers of our past and get proactive by combining the rich human talents we currently find in our classroom teachers, supervisors, and teacher educators. Capitalize on those talents we currently possess to build a foundation for that which we can become. Let's be willing to get help in this area and let's get help now—not wait until tomorrow. When we are willing to accept that we may just not have all the answers, then we will be on track to becoming a mature profession of educators. Build and cultivate partnerships, both within and outside the profession. The time for change is now.

Cut loose from the past and any excess baggage it may bring with it. Be creative. Be willing to try something new even if we fail at first. Take chances. Gamble. Let our visions run wild while at the same time focusing our energies on a common mission—a mission that is supported by all the stakeholders. Identify the major stakeholders at all levels of education and actively engage them in our total program of work. We should not be afraid of getting radical with our ideas while staying focused on our mission. Let's develop the partnerships at all levels of education that in our past we either failed to develop or were afraid to develop. In addition, let's develop and then market a justification as to why we should exist in every school setting. (I believe, and I hope you believe also, that making a significant contribution to the development of technologically literate people is the reason why we should exist.) Spend constructive time and change the misconceptions that exist and then develop positive images that we want the public to have about us. Get in the driver's seat. Get proactive, not reactive. The time for change is now.

As a profession, we have spent a lot of time and energy focusing on our curriculum—and we should have. At times, unfortunately, we have done this at the expense of addressing other critical needs including the development of a cadre of professionals. We have experienced a declining number of teacher preparation programs, a declining number of people being certified as technology teachers, and a declining number of K-12 students enrolling in our programs. I submit there are identifiable reasons for these declines and once they are fully addressed, they will disappear. I fear the clock is ticking ever so fast and the problem may soon be out of control, if not already. Let's come together and focus positive energies on the problem of a dwindling number of people in our programs—at all levels. It may require that we put curricular concerns on hold for if we do not have the people to deliver the curriculum, then we have wasted considerable human energy. At all levels our professional conferences should be focusing on this very important topic rather than on many of the topics currently found on conference programs. The time for change is now.

Historically, we reserved to teacher education institutions the right and obligation to conduct formal research for our profession. Teacher educators set the research agenda including its role, scope, and sequence. Now, with a dwindling number of programs and educators at the post-secondary level, a much larger body of people must become actively involved in setting the agenda and conducting the research. Every technology teacher has an obligation to serve as a member of a much larger team to help set technology education's research agenda, and then implement it. We need compelling research-based reasons that we can communicate to the decision-makers that what students learn in technology education is not only socially acceptable, but distinctly different from learning in other curriculum areas. Many other topics need to be researched as we identify these compelling reasons. Equally important, we need people with strong research skills who will also serve as mentors to aspiring researchers. I fear we have a major problem in our profession right now in the whole area of establishing a research agenda, mentoring researchers, and conducting meaningful research. The time for change is now.

Finally, and to draw closure on this yearbook, I hope your attention has been drawn to two central themes. In several essays, authors identified what we currently do best— our exemplary practices. We can be proud that we bring a host of success stories to cross the threshold into the new millennium. Similarly, we can be equally proud that another group of authors identified a host of topics for our 21st century agenda. All topics are vitally important to our future, but simply admitting they are important is not enough. Now, the technology education profession needs you to step-up your commitment and make things happen. If you are not currently a change agent, you must become one. We need you now more than ever before. While selected individuals may have been able to move the profession forward during the 20th century, the profession now needs a total commitment from all its stakeholders for the 21st century. Every technology educator has a role to play and to play it well. Nothing less than a total commitment to change is acceptable. The burden is on you, no one else. Will you work aggressively to bring about significant change in technology education for the 21st century? Only you can answer that question.

Index

E

F

G

H

I

M

N

O

P

Q

R

S

T

U

V

W

Z