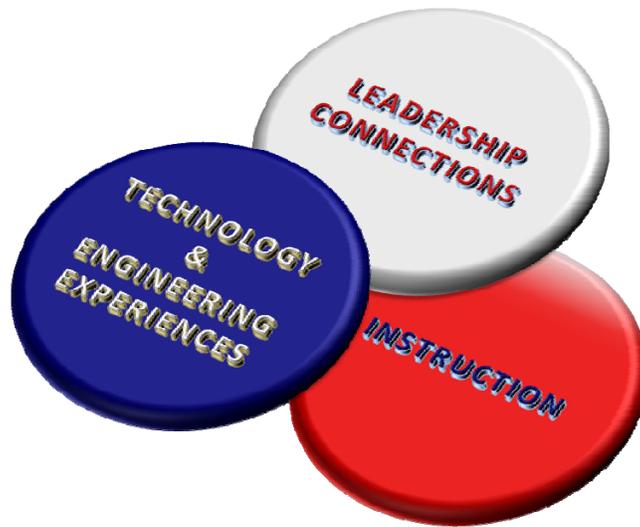




## **Program Planning Handbook**



# A STEM CALL TO ACTION

---

Kendall N. Starkweather, DTE  
International Technology Education Association

With the rapid advances in technology and the plethora of changes in society that involve new, life-changing inventions, education has had to attempt to keep pace. Technology and engineering must become a part of the “new basic” in our next generation of general education for all students. Societal members are being made aware of advances in thinking that allows human ingenuity and technology to be used in the solution of problems facing our world today.

Take this opportunity to gain a better understanding of the need for STEM education and its critical role in creating a technologically literate society in which individuals use their thinking skills to fulfill human wants and needs. The rationale for the “T” and “E” has been specifically addressed in order to gain support for these subjects as part of the overall STEM effort. Technology and engineering have proven to be critical components in solving societal problems. Alone, science and mathematics fall short of allowing students to truly implement the knowledge necessary to make a better society.

The following are ways that the concerned citizen can help make such an education a reality. Join dedicated and engaged colleagues from across the country who strive to make a difference in an education for the next generation.

## Parents

Don't settle for less than the best education for your child at any age level. If your child likes to make or create and seems technologically inclined in any way, have him or her explore these courses. Technology and engineering are for students who envision themselves as architects, high-tech workers, technicians, and more. These experiences or courses are not limited only to future engineers! Technology and engineering can and should be taught from the earliest grades through the university level. Knowledge about science and mathematics alone does not provide the full experience necessary to make an inventor or creator. The teaching solution does not have to be an expensive facility with constant upgrades that are a burden on a school's finances. Examine your options; seek information about programs already making a difference in communities across the United States; request that your administrators become informed about opportunities to make technology and engineering a meaningful

*We must count on technology and engineering teachers and their students' imaginations to help us meet the needs of the 21st Century.*

part of a STEM education. A technology and engineering education is a sound investment for all students, but currently gets very little support.

### School Administrators/ Boards of Education

Our school leaders have a legal responsibility to assure that a curriculum prepares students to live effectively in today's technological society. However, more is needed. Such an education creates opportunities for the student who wants to explore STEM options, enabling them to design, invent, and innovate. School leaders are the curriculum leaders who can help in the search for quality education, not just buying change, but making informed decisions about an education with a unique mindset, one that is technological in nature. Let your school leaders know of your interest in having a strong technology and engineering curriculum. Help guide them toward knowing more about such programs.

### Governmental Agencies

Sustained support for technology and engineering has come from state and national agencies such as the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA). There still remains, however, a need for departments of education at both the state and national levels to become more involved and gain a deeper understanding of this type of education.

If STEM education is to be notably effective, it has to become more than the science and mathematics education of the past. Agency personnel must understand that technology provides much more than the delivery of instruction and that it has a content base of its own—focusing on technological literacy. To date, there has been little evidence of understanding by departments of education of how technology and engineering are different and yet crucial in strengthening science and mathematics education. More of the same education as in the past is not the answer. Supporting an education that promotes knowledge and understandings about technological literacy is the answer to having a stronger STEM program. All concerned citizens should assist these agencies in fully understanding technology and engineering programs. Until they do, little progress



*Technology and engineering have proven to be critical components in solving societal problems. Alone, science and mathematics fall short of allowing students to truly implement the knowledge necessary to make a better society.*

# A STEM Call to Action

will be made towards funding that will truly make technology and engineering equal STEM subjects.

## Legislative Bodies

While legislators do not determine curriculum content for the public school, they can express to school leaders their interest in having stronger technology and engineering programs as a part of a STEM education. Few elected officials have an adequate background that would allow them to fully understand the issues related to a strong program. They must be made aware of the many opportunities to provide a technological education—and that teaching the “S” and “M” of STEM alone shortchanges students of the full benefits of a STEM education.

At the same time, legislators should be encouraged to advance STEM legislation in such a way that STEM subjects thrive in our schools—including legislation promoting more technology and engineering teachers, greater professional development, and an emphasis on ending technology and engineering teacher shortages. The shortage of qualified STEM teachers will make the job of education in creating a 21st Century Workforce more difficult. As a country, we need to act now to make our educational system STEM strong. As community leaders, we must make our concerns known.

## Corporate Leaders

Corporate leaders can play many key roles in promoting technology and engineering education. They can become major advocates for the type of thinking that supports inventive thinking—learning to use design as a process in creating, and expressing the need for an education to prepare a technological worker. Their influence in both state and national legislation can bring attention to the need for informed workers with a background appropriate for tomorrow’s technological world. Educators should be working with corporate leaders to utilize their resources with boards of education and on advisory groups. At the same time, corporate leaders should take advantage of every opportunity to advocate for the type of worker needed in their industries. These back-and-forth relationships provide student educational opportunities, prepared corporate employees, and an informed citizenry that can make better-informed decisions about technological issues that face our society.

## Summary

The teachers who have provided the preceding program descriptions do not know all of the challenges that lie ahead for themselves or their students. Their current programs are in transition towards ideals that they are pursuing with an emphasis on technology and engineering within STEM. Even with this emphasis, science and mathematics are a key part of their teaching. These are veteran teachers who have had their share of failures and successes in both the classroom and the laboratories that they manage. They continue to explore new ideas and various areas of research and developed materials to become outstanding educators in tune with the leadership of the profession.

There are many teachers throughout the United States and in other countries who are experiencing the same type of excitement that captures one’s ability to design, create, and innovate. These programs have many different titles that include technology, innovation, design, and engineering in one form or another. Therefore, we are seeing the spawning of an important subject area that can do much to prepare next-generation workers capable of using their talents in many ways to advance our fast moving, highly technological society.

The mission of such programs must be to increase understanding of technological literacy and design among all people. A strong STEM program is a curriculum thrust that works toward the mission by presenting the insight, providing the drive and communication, and questioning the efficiency of methods and approaches while delivering material of significance to people who will be experiencing sophisticated technology for the rest of their lives.

## Table of Contents

<b>Chapter 1 — Technology and Engineering Education .....</b>	<b>1-10</b>
1. Introduction	
2. Definitions and Terms	
3. Philosophy of Technology and Engineering	
4. Content of Technology and Engineering	
5. Mission and Goals of Technology and Engineering	
<b>Chapter 2 — State and National Standards.....</b>	<b>1-25</b>
1. Introduction: What are the Standards?	
2. Who Developed the Standards	
3. Technology and Engineering Standards	
4. Missouri Show — Me Standards	
5. Crosswalks between the Missouri Show — Me Standards and the Technology Content Standards	
<b>Chapter 3 — Elementary School Technology and Engineering.....</b>	<b>1-3</b>
1. Introduction	
2. Why Should Elementary Students Study Technology and Engineering?	
3. Course Content, Unit Descriptions, and Resources	
<b>Chapter 4 — Middle School Technology and Engineering .....</b>	<b>1-25</b>
1. Introduction	
2. Course Titles, Codes and Descriptions	
3. Curriculum Thrust: Engagement and Engagement	
4. Nature of the Learner	
5. Transforming the Middle School Education	
6. Career and Educational Exploration	
7. Changing Emphasis in Technology and Engineering	
8. Documenting Student Achievement of Content Standards across Grade Levels	
9. Methods: Strategies for Standards-based Instruction	
<b>Chapter 5 — High School Technology and Engineering .....</b>	<b>1-5</b>
1. Introduction	
2. Course Selection, Descriptions, and Rationales	
<b>Chapter 6 — Technology Student Association (TSA).....</b>	<b>1-7</b>
1. Introduction	
2. Mission	
3. Local Chapters	



4. Why Join TSA?
5. How to Join TSA
6. About TSA
7. Goals of Technology and Engineering
8. The Benefits to having a TSA Chapter
9. Official Charter Information
10. Steps to Starting a TSA Chapter
11. Curriculum Event Information
12. TSA's History

**Chapter 7 — Teaching Technology and Engineering..... 1-19**

1. Introduction
2. Planning Instruction
3. Selecting Instructional Materials
4. Meeting Students Individual and Special Needs
5. Providing for Equity
6. Evaluating Student Performance
7. Career and Technical Student Organizations (CTSO's)
8. Developing Employability Skills

**Chapter 8 — Organizing and Managing a Technology and Engineering Program ..... 1-8**

1. Introduction
2. Accessing Key Resource Personnel
3. Using Partnership Advisory Councils

**Chapter 9 — Technology and Engineering Program Evaluation ..... 1-5**

1. Introduction
2. Local (internal) Evaluation
3. School Accreditation
4. Missouri Technology and Engineering Program Standards and Quality Indicators Self-Assessment
5. Program Planning Quality Control

**Chapter 10 — Professional Development ..... 1-7**

1. Introduction
2. Definition of Professional Development
3. The Continuous Nature of Professional Development
4. Evaluating TE Teacher Effectiveness
5. Performance-Based Evaluation

<b>Chapter 11 — Resources</b> .....	<b>1-3</b>
1. Web-Based Resources	
<b>Glossary</b> .....	<b>1-9</b>
<b>Appendices and References</b> .....	<b>1-20</b>
1. Appendix—A <i>Standards for Technological Literacy</i>	
2. Appendix—B <i>Advancing Excellence in Technological Literacy</i>	
3. Appendix—C <i>Missouri Show-Me Standards</i>	
4. Appendix—D <i>STEM Cluster Programs of Study</i>	
5. Appendix—E <i>Responsibility Matrix for STL Standards and Benchmarks</i>	
<b>References</b> .....	<b>20</b>
Total Document Pages .....	1-156



## **Chapter 1 – Technology and Engineering Education**

**MISSOURI DEPARTMENT OF ELEMENTARY AND SECONDARY EDUCATION  
DIVISION OF CAREER EDUCATION**

# Chapter 1

## Technology and Engineering Education

### 1 – Introduction

Technology has been going on since humans first formed a blade from a piece of flint, harnessed fire, or dragged a sharp stick across the ground to create a furrow for planting seeds, but today it exists to a degree unprecedented in history. Planes, trains, and automobiles carry people and cargo from place to place at high speeds. Telephones, televisions, and computer networks help people communicate with others across the street or around the world. Medical technologies, from Magnetic Resonance Imaging (MRI) to vaccines, help people to live longer, healthier lives. Furthermore, technology is evolving at an extraordinary rate, with new technologies being created and existing technologies being improved and extended.



Humans have been called the animals that make things (as well as design things), and at no time in history has that been as apparent as the present. The U.S. Patent Office reports that since its beginning in 1792, about 70% of all U.S. patents ever issued have been since 1935. More than a third of all patents have been issued in the past twenty years.

Today every human activity is dependent upon various tools, machines, and systems, from growing food and providing shelter to communication, healthcare, and entertainment. Some machines, like the tractor, speed up and make more efficient activities that humans have done for hundreds or thousands of years. Others, such as the airplane or the Internet, make possible things that humans have never been able to do before. This collection of devices, capabilities, and the knowledge that accompanies them is called technology (Dyrenfurth & Kozak, 1991).

We are a nation increasingly dependent on technology. Yet, in spite of this dependence, U.S. society is largely ignorant of the history and fundamental nature of the technology that sustains it. The result is a public that is disengaged from the decisions that are helping shape its technological future. In a country founded on democratic principles, this is a dangerous situation. In an August 2003 National Science Foundation funded report from the National Science Board (NSF), it is clearly stated:

Science and technology have been and will continue to be engines of US economic growth and national security. Excellence in discovery and innovation in science and engineering derive from an ample and well-educated workforce – skilled practitioners with two- and four-year degrees and beyond, researchers and educators with advanced degrees, and pre-college teachers of mathematics and science [and technology] (NSF, 2003, p. 1).

The U.S. Commission on National Security/21st Century (2001) also spelled out clearly the importance of technology:

The scale and nature of the ongoing revolution in science and technology, and what this implies for the quality of human capital in the 21st century, pose critical national security challenges for the United States. Second only to a weapon of mass destruction detonating in an American city, we can think of nothing more dangerous than a failure to manage properly science, technology, and education for the common good over the next quarter century (NSF, 2003, p. 1).

With the growing importance of technology to our society, it is vital that students receive an education that emphasizes technological literacy. (ITEA, 2000) This document, together with the national Standards for Technological Literacy: Content for the Study of Technology, present a vision of what students should know and be able to do in order to be technologically literate, and what school programs

should look like to achieve that vision. Yet, the study of technology cannot and does not exist in a vacuum isolated from other academic and career subjects. The delivery of Technology and Engineering must share in this responsibility and be a contributing member of the school instructional team to enhance core academic knowledge and skills, especially mathematics and science.

## 2 – Definitions and Terms

**Design:** Technological Design, according to the Standards for Technological Literacy, Content for the Study of Technology (STL), is a distinctive process which has a number of defining characteristics. Design is a process which has a defined purpose with identifiable requirements (constraints) and follows a systematic approach allowing for iteration. The design process encourages human creativity utilizing intuition, feelings, and impressions leading to the designer’s “best possible solution.”

**Engineering:** Engineering is the art of applying scientific and mathematical principles, experience, judgment, and common sense to make things that benefit people. Engineering is the process of producing a technical product or system to meet a specific need. In other words, engineering is a process used for solving problems relevant to our lives.

**Engineering Technology:** Engineering technology is the profession in which knowledge of mathematics and natural sciences are used to create and enhance technologies that benefit humanity. Engineering technologists and technicians deal with application, manufacturing, implementation, engineering operation, sales, and production as opposed to the conceptual design and research functions performed by many engineers.

**Missouri Career Paths:** These clusters of occupations that require different levels of education and training. People working in a career path share interests, abilities, and talents. Career Paths help students identify a career focus without being locked into a specific occupation. With career paths, students are able to begin preparing for a career, but still have the flexibility needed in today’s constantly shifting work world. Missouri has identified six Career Paths that are broad in nature. The Career Paths that Technology and Engineering pays close attention to are shown in bold font. The States’ Career Clusters that match with the Missouri Career Paths follow each cluster (see Table 1).

<b>Table 1 States’ Career Clusters &amp; Missouri Career Paths Comparison</b>	
<b>Missouri Career Paths</b>	<b>States’ Career Clusters</b>
Arts and Communication	Arts, A/V Technology & Communications; Architecture and Construction
Business, Management & Technology	Science, Technology, Engineering & Mathematics
<b>Industrial &amp; Engineering Technology</b>	Science, Technology, Engineering & Mathematics; Transportation, Distribution & Logistics; Manufacturing; and Architecture & Construction
Natural Resources/Agriculture	Agriculture, Food & Natural Resources
Health Services	Health Science
Human Services	Human Services

Professional Teacher/Educator: In the broadest sense, a professional educator is a teacher that never stops learning nor wants to stop learning. The professional educator continues to look for ways to improve instruction, knowledge, and collegiality with other professional educators. Professional growth begins the first day of their career and never ends (The Master Teacher, vol. 25, no. 34). Ultimately, this process of growth has only one goal, to serve the needs of their students today, tomorrow, and in the future. To the professional educator, successfully serving students requires a clear understanding of their needs. When a student walks into a technology teacher’s classroom/lab, the student does not leave their academic or emotional needs outside. They step into the lab as a whole person with all of their emotional and academic needs attached. The professional educator has a clear understanding of not only the content of their course or program but that of other academic programs in the school building and the school district. Professional educators will be familiar with the entire K-12 curriculum, which better positions them to plan for their own programs and meet the needs of the whole student. Educators will be prepared to address core content as well as their own content found in their technology program. In addition, collegially, “...when teachers begin to show a professional interest in and awareness of what colleagues are doing in their classrooms and schools, new staff relationships emerge.” (The Master Teacher, vol. 21, no. 22) These new relationships will only help increase the capabilities of the professional educator who in turn helps students achieve academically.

States’ Career Clusters: “A Career Cluster is a grouping of occupations and broad industries based on commonalities. Career clusters provide an organizing tool for schools, small learning communities, academies and magnet schools. Career clusters identify Pathways from secondary school to two- and four-year colleges, graduate school, and the workplace, so students can learn in school and what they can do in the future. This connection to future goals motivates students to work harder and enroll in more rigorous courses. Career clusters provide students with relevant contexts for learning” (National Association of State Directors of Career Technical Education Consortium, 2002). States’ Career Clusters, as identified by the National Association of State Directors of Career Technical Education Consortium (<http://www.careerclusters.org>), are organized into sixteen groups. The career clusters Technology and Engineering is most concerned with are shown in bold type (see Table 2).

Table 2 States’ 16 Career Clusters	
Agriculture, Food, & Natural Resources	Health Science
Architecture & Construction	Human Services
Arts, A/V Technology & Communications	Information Technology
Business, Management & Administration	Law, Public Safety & Security
Education & Training	Manufacturing
Finance	Marketing, Sales & Service
Government & Public Administration	Science, Technology, Engineering & Mathematics
Hospitality & Tourism	Transportation, Distribution & Logistic

Technology: Broadly speaking, technology is how people modify the natural world to suit their own purposes. From the Greek word technē, meaning art or artifice or craft, technology literally means the act of making or crafting, but more generally it refers to the diverse collection of processes and knowledge that people use to extend human abilities and to satisfy human needs and wants through a process of design (ITEA, 2000, p. 2).

Technology and Engineering (TE): The school subject that teaches about the processes used to design, create, and maintain the human-made world through the integration of technical, mathematical, and scientific knowledge and skills. (Technological studies, design and innovation and pre-engineering are other terms used to describe this subject area).

Technological Literacy: The ability to use, manage, assess, and understand technology. A technologically literate person understands (in increasingly sophisticated ways that evolve over time) what technology is, how it is created, and how it shapes society, and in turn is shaped by society. He or she would be able to hear a story about technology on television or read it in the newspaper and evaluate the information in the story intelligently, put that information in context, and form an opinion based on that information. A technologically literate person would be comfortable with and objective about technology neither scared of it nor infatuated with it (ITEA, 2000, p. 9).

Technology is the modification of the natural environment in order to satisfy perceived human needs and wants (ITEA, 2000, p. 9). A great benefit when learning about technology is the opportunity one has to do technology (ITEA, 2000, p. 2). A very strong implication in this definition of technology is that technology must involve design. The process of design is central to the practice of engineering and a key element in Technology and Engineering. If one is good at design, it follows that one will have a tacit knowledge of materials, artifacts, and systems as they relate to each other (Technically Speaking, p.58). In learning to do design, students will master a set of abilities that will serve them well throughout their lives (ITEA, 2000, p. 2). However, design is often defined or viewed in various ways. It often means different things to different people. Therefore it is important to establish a common definition for design as it is addressed in this document. This will allow common ground and common understanding for the importance of design in education and more importantly, Technology and Engineering.

### **3 – Philosophy of Technology and Engineering**

Our world will be very different 10 or 20 years from now. We have no choice about that. We do, however, have a choice whether we march into that world with our eyes open, deciding for ourselves how we want it to be, or whether we let it push us along, ignorant and helpless to understand where we're going or why. A technological literate society will make the difference (ITEA, 2000, p. 10). The achievement of a technologically literate society is a societal goal that is supported by K-12 Technology and Engineering programs.

Missouri's Technology and Engineering profession affirms that its programs should teach about technology and use technology in a way that serves as a vehicle to build understanding, skills, and attitudes that can be applied to society in general, i.e., technological literacy, regardless of students' career aspirations. Furthermore because all people are affected by technology, and technology has an increasing presence in our lives, students from kindergarten to twelfth grade should be involved with learning about and learning to use technology. Learning should extend not only to enhancing human capability but to using technology to design the build environment (sometimes referred to as engineering design). It is therefore recommended that a K-12 technology literacy program be in place in the state of Missouri to insure high school graduates are technologically literate.

Technology and Impacts on Daily Life as a Force Has Affected Most Aspects of Our Lives Business and industry have been required to grapple with technology engendered issues such as design/engineering, productivity, technological capability and global competitiveness. Workers have been challenged to retrain and develop currently marketable skills—in cognitive, affective and psychomotor domains—in order to maintain their ability to support themselves and contribute to our free-enterprise economy. And with technology's advances, Americans find these skills to be constantly changing.

Legislators have also been pressed to understand technology and its effects as they work to frame policies for the public good. With the rampant escalation of both the amount and complexity of technology, it is increasingly difficult for people to exercise appropriate citizenship functions, particularly given the

curtain of confusion raised by technology and its media offspring.

Consequently, citizens have often found themselves bewildered by increasingly complex consumer decisions. Frequently they face decisions involving trade-offs between immediate gains and negative consequences, e.g. the effects of toxic wastes. Similarly, recreational environments and activities have increasing technological components, as do personal and societal learning activities.

Technology's pervasive influence has permeated even our homes. Our lifestyle is timed, microwaved, accelerated, recorded, computerized and confounded. A greater proportion of people are working, families are resorting to schedules to program their contact, and others are unemployed due to technological advances. Outside knowledge is pouring into the home via cable television and other media. Not infrequently the tensions from external aspects of life, many of which are technologically induced, do come home in the form of stress.

Even in social service arenas such as the health sciences, technological capabilities have caused us to ponder when enough is enough. We ask, for example, to what end do we operate life support systems in situations currently deemed hopeless?

### **Technology and Social Context**

Contemporary and future society is clearly different from what America experienced during its first industrial revolution. To be sure, some elements of the industrial revolution remain, but many more have changed. Technology as a force has affected most aspects of our life, and thus technology seems to be the single most distinctive characteristic that sets today and the future apart from our past.

Evidence of this is seen in the literature. For example, there are frequent references to the post-industrial society, from the demise/reduction of smoke stack industries and to the information society. Furthermore, we have seen tangible evidence of such shifts in our automotive, steel, petroleum and electronics industries.

### **Technology and Industry**

But what is technology? Simply stated, it is human kind's use of tools, machines, materials, processes, energy, and knowledge (mathematical, scientific and technical) to satisfy its wants and needs. As such, it is not the search for an explanation of why things work - that is science.

Technology is knowing "how" to design, construct or build something with tools, machines, material processes and energy - and then it necessarily involves being able to do. Knowledge alone is not sufficient. Rather, technology is a combination of knowledge, skills and attitude that is always more powerful than any single component. It takes all of the preceding. Leave off one and the process is incomplete. Operating a machine is not technology in of itself.

Industry is one of human kind's basic institutions. As such, it parallels that of government, religion, and education. It is that institution that supplies our civilization with goods and services to fill our wants and needs. It does so by using technology. The technology used by industry is typically referred to as industrial technology.

### **Implications for Education**

Given the pervasive nature of technology, the Technology and Engineering profession raises the question: "Where do people develop the understanding, skills and attitudes to deal with forces such as technology?" Clearly our society uses formal schooling as a principal method to this end—at least for youth, and in increasing numbers, for adults. It follows then that one must ask, "What are the schools doing to help youth and adults address technology's challenges?" What systematic efforts are in place to develop technologically appropriate understanding, skills, and attitudes in elementary, secondary, post-secondary, adult and continuing education?

A technological program with a well developed standards-based scope and sequence is certainly the place to begin. Technology teachers have a bright future in the state of Missouri.

### **Technology and Engineering’s Relationship to Career and General Education**

Given these contexts, it is clear that Technology and Engineering (TE) must be an essential component of both general education, and career education (formally referred to as vocational education). Only in this way can Technology and Engineering serve as:

- ◆ the component of general education that develops generalizable understandings, capabilities, values and attitudes related to technology in all youth.
- ◆ a reinforcement of core academic knowledge and skills through practical application in technology related activities.
- ◆ a component of specialized education that contributes to meaningful occupational choice and/or preparation in a technological society.

Because of these dimensions and TE’s approach, it has an essential role in helping build the base that leads to successful transition plans such as Tech-Prep and/or 2+2 or 2+2+2 programs. Professional leaders need to be alert to opportunities that further the program’s contributions to Missouri’s youth as enabled by the Carl D. Perkins Vocational and Applied Technology Education Act.

### **4 – Content of Technology and Engineering**

Just as technology spans across all aspects of human activity, Technology and Engineering draws its content from the entire range of technological endeavors, not just industry. Content is also selected by identifying the competencies individuals need to effectively use the products of a technological society.

Given the preceding philosophy and foundation, it is clear that the educational program known as Technology and Engineering derives its content, i.e. the subject matter it teaches, from technology, and not just industry. Technology and Engineering is therefore considered to be a body of knowledge or a discipline.

Industrial technology is a *subset* of technology and many of its aspects can be generalized to technology. To clarify:

- ◆ Technology consists of all human productive endeavors including agriculture, bio- and medical technologies and engineering technologies.
- ◆ Industrial technology is the technology that is used by industry. As such, industrial technology coexists with agricultural and other technologies.
- ◆ Industrial technology consists of three technology system clusters: Materials & Processing, Energy & Power, and Communication.
- ◆ Industrial Technology and Engineering focuses on learning the technologies of industry.
- ◆ Technology and Engineering education focuses on all of the technologies used by human kind.

### **5 – Mission and Goals of Technology and Engineering**

Since industry and technology are distinctive characteristics of American culture, and since one of the key purposes of education is to transmit the culture to future generations, it follows that it is necessary for the schools to provide youth with an insight into, an understanding of, and selected capabilities with the technological nature of this society. Industry and technology spring from the human ability to reason, solve problems, create/design/engineer, construct, and use materials, tools, machines and processes imaginatively. Because these abilities are an integral part of our technological culture they should be developed in all students—regardless of their gender, background, educational goals or occupational aspirations.

The overarching mission of Technology and Engineering as a school program is to develop the human potential of all students for responsible work, citizenship and leisure roles in a technological society.

To accomplish this, programs must address each of its four primary missions, namely to:

- ◆ Develop each person's ability to comprehend and apply the concepts of technological systems through the design/engineering process which includes the integration and application of mathematical and scientific knowledge.
- ◆ Develop each person's values and attitudes related to the appropriate use of technology—its tools, machines, materials, processes, and products.
- ◆ Develop each person's ability to use materials, technological processes and hardware to achieve constructive work skills and enhance occupational opportunity.
- ◆ Develop an awareness of career options and the required technical and academic education for technologically related career clusters and career paths.

Technology and Engineering addresses these four primary missions by purposefully working toward an important set of goals. Simply put, this means that every student participating in any Technology and Engineering program should experience a systematically designed program of instruction and activity that accomplishes each of the 14 goals presented in Figure 1-1.

Technology and Engineering also operates within the context established by the *Standards for Technological Literacy: Content for the Study of Technology (STL)* and the *Missouri Show-Me Standards*. Technology and Engineering is particularly capable of addressing the Show-Me Process Standards. By articulating carefully to such goals, Technology and Engineering instructors can enhance the perceived value of their programs and they can increase the program's contribution to youth.

**Figure 1-1**  
**Missouri Technology and Engineering Program Goals**

Every Student participating in technology and engineering education will experience a systematically designed and delivered program of instruction and activity that addresses two broad goals:

- ◆ Understand and experience technology's creation, application, and control.
- ◆ Understand and develop ways of thinking about technology that consistently respect the environment, promote human well-being, and benefit society.

Consistent with these two goals, technology and engineering education programs in Missouri enable students to:

1. Understand why and how people design, engineer, and innovate to meet human needs and wants.
2. Apply ways of thinking and doing essential to designing and problem solving, developing, making, managing, and assessing technological systems in various contexts.
3. Safely use, manage, and evaluate technological systems and engineering processes.
4. Relate technology and engineering with science, mathematics, and other subjects to understand systems in different contexts and to engineer solutions to practical problems.
5. Communicate technology content and processes, individually as well as in teams.
6. Understand the historical and future significance of engineered designs and impacts of technological solutions.
7. Develop basic skills in the safe use of tools, machines and processes used by industry and other technologies.
8. Foster creativity in using technology for desirable purposes by encouraging students to create, from materials and with technological processes and hardware, new and different forms which have greater or alternative value.
9. Facilitate the discovery of individual talents, aptitudes, interests and potentials related to technology through laboratory activity.
10. Encourage cooperative attitudes, constructive work habits and other traits that will help secure and maintain employment.
11. Develop pride in work done well.
12. Develop consumer skills related to the appropriate production, consumption and maintenance of technological goods and services.
13. Develop an awareness of and appreciation for career paths and opportunities in technology and engineering, and prepare for entrance into advanced secondary and post-secondary career and technical programs by promoting the development of a basic foundation of occupational skills and interests.
14. Develop leadership skills through the Technology Student Association activities.

## Bibliography

\_\_\_\_\_. (n.d.). Educational goals for the state of Missouri. Jefferson City, MO: Missouri Department  
\_\_\_\_\_. (1985). Technology Education: A perspective on implementation. Reston, VA: American  
Industrial Arts Association.

Dyrenfurth, M. J. & Kozak, M. (1991). Technological literacy. Fortieth yearbook, Council on Technology  
Teacher Education. Peoria, IL: Glencoe/McGraw-Hill.

ITEA (2000). Standards for Technological Literacy: Content for the Study of Technology. Reston, VA:  
International Technology Education Association.

ITEA (1999). A Guide to Develop Standards-Based Curriculum for K-12 Technology Education. Reston,  
VA: International Technology Education Association.

ITEA (1996). Technology for All Americans: A Rationale and Structure for the Study of Technology.  
Reston, VA: International Technology Education Association.

Savage, E., & Sterry, L. (Eds.). (1990). A conceptual framework for technology education. Reston, VA:  
International Technology Education Association.



## **Chapter 2 – State and National Standards**

## Chapter 2 State and National Standards

### 1 – Introduction: What Are Standards?

A “standard” is a description of something you want a student to learn, a well-defined goal. The phrase educators like to use is something a student will “know and be able to do.” Teachers should use standards to make decisions about what to teach. Standards tell teachers, students, parents, and administrators what students are expected to know at the end of the teaching and learning process. Teachers should examine everything they do with this question in mind: “Is what I’m teaching part of what we have agreed we want students to know?”

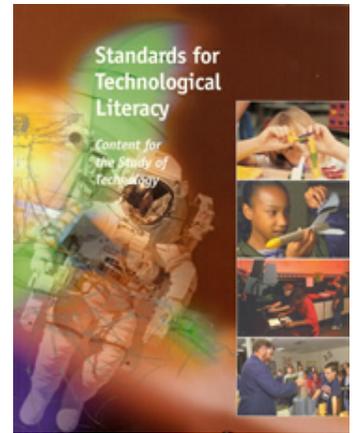
### 2 – Who Developed Standards?

Most curricular area professional organizations have developed national standards and most states have developed state standards. The International Technology Education Association (ITEA) through the *Technology for All Americans Project* (TFAAP), has developed twenty standards for technological literacy. The Missouri Department of Elementary and Secondary Education (MODESE) has developed the Show-Me Standards. Both sets of standards are extremely important for all Missouri students.

### 3 – Technology and Engineering

#### ***Standards for Technological Literacy: Content for the Study of Technology***

The Standards were published by the International Technology Education Association and the Technology for All Americans Project in April 2000. It defines what students should know and be able to do in order to be technologically literate and provides standards that prescribe what the outcomes of the study of technology in grades K – 12 should be. However, it does not put forth a curriculum to achieve these outcomes. Technology Content Standards will help ensure that all students receive an effective education about technology by setting forth a consistent content for the study of technology.



#### **Why are Technology Content Standards (TCS) Important?**

ITEA suggests the following reasons why TCS is important:

- ◆ Technological literacy enables people to develop knowledge and abilities about human innovation in action.
- ◆ Technology Content Standards establishes the requirements for technological literacy for all students – kindergarten through grade 12.
- ◆ Technology Content Standards provides qualitative expectations of excellence for all students.
- ◆ Effective democracy depends on all citizens participating in the decision-making process. Because so many decisions involve technological issues, all citizens need to be technologically literate.
- ◆ A technologically literate population can help our nation maintain and sustain economic progress.

#### **The ITEA offers five guiding principles behind the Technology Content Standards:**

- ◆ They offer a common set of expectations for what students should learn in the study of technology.
- ◆ They are developmentally appropriate for students.
- ◆ They provide a basis for developing meaningful, relevant, and articulated curricula at local, state,

and provincial levels.

- ◆ They promote content connections with other fields of study in grades K – 12.
- ◆ They encourage active and experiential learning.

### **Who is a technologically literate person?**

A person that understands, with increasing sophistication, what technology is, how it is created, how it shapes society, and in turn is shaped by society is technologically literate. He or she can hear a story about technology on television or read it in the newspaper and evaluate its information intelligently, put that information in context, and form an opinion based on it. A technologically literate person is comfortable with and objective about the use of technology, neither scared of it nor infatuated with it.

Technological literacy is important to all students in order for them to understand why technology and its use is such an important force in our economy. Anyone can benefit by being familiar with it. Everyone from corporate executives to teachers to farmers to homemakers will be able to perform their jobs better if they are technologically literate. Technological literacy benefits students who will choose technological careers, future engineers, aspiring architects, and students from many other fields. They can have a head start on their future with an education in technology.

What is included in Technology Content Standards? There are 20 standards that specify what every student should know and be able to do in order to be technologically literate. The benchmarks that follow each of the broadly stated standards at each grade level articulate the knowledge and abilities that will enable students to meet the respective standards. A copy of the Technology Content Standards can be obtained from the International Technology Education Association, 1914 Association Drive, Suite 201, Reston, Virginia, 20191-1539. The ITEA web site, <http://www.iteawww.org>, also provides a copy of the standards on line.

**Figure 2-1**  
**National Standards for Technological Literacy**



### **Listing of STL Content Standards**

#### **The Nature of Technology**

- Standard 1. Students will develop an understanding of the characteristics and scope of technology.
- Standard 2. Students will develop an understanding of the core concepts of technology.
- Standard 3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

#### **Technology and Society**

- Standard 4. Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5. Students will develop an understanding of the effects of technology on the environment.
- Standard 6. Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7. Students will develop an understanding of the influence of technology on history.

#### **Design**

- Standard 8. Students will develop an understanding of the attributes of design.
- Standard 9. Students will develop an understanding of engineering design.
- Standard 10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

#### **Abilities for a Technological World**

- Standard 11. Students will develop abilities to apply the design process.
- Standard 12. Students will develop abilities to use and maintain technological products and systems.
- Standard 13. Students will develop abilities to assess the impact of products and systems.

#### **The Designed World**

- Standard 14. Students will develop an understanding of and be able to select and use medical technologies.
- Standard 15. Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.
- Standard 16. Students will develop an understanding of and be able to select and use energy and power technologies.
- Standard 17. Students will develop an understanding of and be able to select and use information and communication technologies.
- Standard 18. Students will develop an understanding of and be able to select and use transportation technologies.
- Standard 19. Students will develop an understanding of and be able to select and use manufacturing technologies.
- Standard 20. Students will develop an understanding of and be able to select and use construction technologies.

## **4 – Missouri Show-Me Standards**

All Missourians are eager to ensure that graduates of Missouri’s public schools have the knowledge, skills and competencies essential to leading productive, fulfilling and successful lives as they continue their education, enter the workforce and assume their civic responsibilities. Schools need to establish high expectations that will challenge all students to reach their maximum potential. To that end, the Outstanding Schools Act of 1993 called together master teachers, parents and policy-makers from around the state to create Missouri academic standards. These standards are the work of that group.

The academic standards incorporate and strongly promote the understanding that active, hands-on learning will benefit students of all ages. By integrating and applying basic knowledge and skills in practical and challenging ways across all disciplines, students experience learning that is more engaging and motivating. Such learning stays in the mind long after the tests are over and acts as a springboard to success beyond the classroom.

These standards for students are not a curriculum. Rather, the standards serve as a blueprint from which local school districts may write challenging curriculum to help all students achieve their maximum potential. Missouri law assures local control of education. Each school district will determine how its curriculum will be structured and the best methods to implement that curriculum in the classroom.

Missouri students must build a solid foundation of factual knowledge and basic skills in the traditional content areas. The statements listed in the Show – Me Standards represent such a foundation in reading, writing, mathematics, world and American history, forms of government, geography, science, health/physical education and the fine arts. This foundation of knowledge and skills are also incorporated into courses in vocational education and practical arts such as Technology and Engineering. Students should acquire this knowledge base at various courses of study. Each grade level and each course sequence should build on the knowledge base that students have previously acquired.

There are two parts to the Show – Me Standards, Knowledge Standards and Performance Standards. Knowledge Standards cover the academic areas of Communication Arts, Mathematics, Science, Social Studies, Fine Arts, and Health & Physical Education. Performance Standards cover four goals: Goal 1. Students in Missouri public schools will acquire the knowledge and skills to gather, analyze and apply information and ideas; Goal 2. Students in Missouri public schools will acquire the knowledge and skills to communicate effectively within and beyond the classroom; Goal 3. Students in Missouri public schools will acquire the knowledge and skills to recognize and solve problems; Goal 4. Students in Missouri public schools will acquire the knowledge and skills to make decisions and act as responsible members of society.

(see appendix C for a list of the Show—Me Standards)

## **5 – Crosswalk Between the Missouri Show – Me Standards and The Technology Content Standards**

Technology and Engineering teachers have the same professional responsibility to implement and hold their students accountable for the Missouri Show – Me Standards as does all other academic teachers. In addition, technology education teachers have the professional responsibility to implements and hold their students accountable for the national *Standards for Technological Literacy: Content for the Study of Technology*. There need not be a conflict between the two sets of standards. As pointed out in the narrative of the Missouri Show – Me Standards document, the practical arts domain is a part of and has a responsibility for the delivery of the Show – Me Standards.

The following tables demonstrate the crossover from each standard. When the technology and engineering teacher integrates their “standards-based” curriculum, both the Show – Me Standards and the Technology Content Standards are best processed simultaneously. The most obvious and the easiest crossover is in the Performance Goal.



**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 1	Standards for Technological Literacy																											
	Standard 5						Standard 6						Standard 7						Standard 8									
	G	H	I	J	K	L	H	I	J	K	L	M	N	O	G	H	I	J	K	L	M	N	O	H	I	J	K	
<b>Goal 1:</b> Acquire the knowledge & skills to gather, analyze & apply informative ideas																												
1. Develop questions & ideas to initiate & refine research	X				X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2. Conduct research to answer questions & evaluate information & ideas	X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3. Design & conduct field & laboratory investigations to study nature & society	X				X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4. Use technological tools & other resources to locate, select & organize information	X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5. Comprehend & evaluate written, visual & oral presentations & works	X				X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6. Discover & evaluate patterns & relationships in information, ideas & structures	X				X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7. Evaluate accuracy of information & reliability of sources	X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8. Organize data, information & ideas into useful forms (including charts, graphs, out-lines) for analysis or presentation	X				X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9. Identify, analyze & compare institutions, traditions & art forms of past & present societies	X				X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
10. Apply acquired information, ideas & skills to different contexts as students, workers, citizens & consumers	X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

**Standards for Technological Literacy - Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 1	Standards for Technological Literacy																													
	Standard 9						Standard 10						Standard 11						Standard 12						Standard 13					
	I	J	K	L			I	J	K	L			M	N	O	P	Q	R			M	N	O	P	J	K	L	M		
<b>Goal 1:</b> Acquire the knowledge & skills to gather, analyze & apply informative ideas																														
1. Develop questions & ideas to initiate & refine research							X	X	X	X	X														X	X	X	X		
2. Conduct research to answer questions & evaluate information & ideas							X	X	X	X	X														X	X	X	X		
3. Design & conduct field & laboratory investigations to study nature & society							X	X	X	X	X														X	X	X	X		
4. Use technological tools & other resources to locate, select & organize information							X	X	X	X	X														X	X	X	X		
5. Comprehend & evaluate written, visual & oral presentations & works							X	X	X	X	X														X	X	X	X		
6. Discover & evaluate patterns & relationships in information, ideas & structures							X	X	X	X	X														X	X	X	X		
7. Evaluate accuracy of information & reliability of sources							X	X	X	X	X														X	X	X	X		
8. Organize data, information & ideas into usefull forms (including charts, graphs, out-lines) for analysis or presenta-tion							X	X	X	X	X														X	X	X	X		
9. Identify, analyze & compare institutions, traditions & art forms of past & present societies							X	X	X	X	X														X	X	X	X		
10. Apply acquired information, ideas & skills to different contexts as students, workers, citizens & consumers							X	X	X	X	X														X	X	X	X		

**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 1	Standards for Technological Literacy																																							
	Standard 14						Standard 15						Standard 16						Standard 17						Standard 18															
	K	L	M	K	L	M	N	M	L	K	J	N	M	L	K	J	N	M	L	K	J	O	P	Q	J	K	L	M												
<b>Goal 1:</b> Acquire the knowledge & skills to gather, analyze & apply informative ideas																																								
1. Develop questions & ideas to initiate & refine research																																								
2. Conduct research to answer questions & evaluate information & ideas																																								
3. Design & conduct field & laboratory investigations to study nature & society																																								
4. Use technological tools & other resources to locate, select & organize information																																								
5. Comprehend & evaluate written, visual & oral presentations & works																																								
6. Discover & evaluate patterns & relationships in information, ideas & structures																																								
7. Evaluate accuracy of information & reliability of sources																																								
8. Organize data, information & ideas into useful forms (including charts, graphs, out-lines) for analysis or presentation																																								
9. Identify, analyze & compare institutions, traditions & art forms of past & present societies																																								
10. Apply acquired information, ideas & skills to different contexts as students, workers, citizens & consumers																																								

**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards	Standards for Technological Literacy													
	Standard 19							Standard 20						
	L	M	N	O	P	Q	R	J	K	L	M	N		
<b>Goal 1</b> : Acquire the knowledge & skills to gather, analyze & apply informative ideas	X	X	X											
1. Develop questions & ideas to initiate & refine research	X	X	X				X					X		
2. Conduct research to answer questions & evaluate information & ideas	X	X	X				X					X		
3. Design & conduct field & laboratory investigations to study nature & society								X						
4. Use technological tools & other resources to locate, select & organize information	X	X	X				X	X				X		
5. Comprehend & evaluate written, visual & oral presentations & works	X	X	X				X					X		
6. Discover & evaluate patterns & relationships in information, ideas & structures												X		
7. Evaluate accuracy of information & reliability of sources	X	X	X				X	X				X		
8. Organize data, information & ideas into usefull forms (including charts, graphs, out-lines) for analysis or presentation	X	X	X				X	X				X		
9. Identify, analyze & compare institutions, traditions & art forms of past & present societies												X		
10. Apply acquired information, ideas & skills to different contexts as students, workers, citizens & consumers	X	X	X				X	X				X		

**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 2	Standards for Technological Literacy																			
	Standard 1					Standard 2					Standard 3					Standard 4				
	J	K	M	W	X	Y	Z	AA	BB	CC	DD	EE	FF	G	H	I	J	H	I	J
<b>Goal 2:</b> Acquire the knowledge & skills to communicate effectively within and beyond the classroom																				
1. Plan & make written, oral & visual presentations for a variety of purposes & audiences																				
2. Review & revise communications to improve accuracy & clarity																				
3. Exchange information, questions & ideas while recognizing the perspectives of others																				
4. Present perceptions & ideas regarding works of the arts, humanities & sciences																				
5. Perform or produce works in the fine and practical arts				X	X							X	X	X						X
6. Apply communication techniques to the job search & to the workplace				X																
7. Use technological tools to exchange information and ideas				X	X															
8. Organize data, information & ideas into useful forms (including charts, graphs, out-lines) for analysis or presentation																				

**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 2	Standards for Technological Literacy																			
	Standard 1					Standard 2					Standard 3					Standard 4				
	J	K	M	W	X	Y	Z	AA	BB	CC	DD	EE	FF	G	H	I	J	H	I	J
<b>Goal 2:</b> Acquire the knowledge & skills to communicate effectively within and beyond the classroom																				
1. Plan & make written, oral & visual presentations for a variety of purposes & audiences																				
2. Review & revise communications to improve accuracy & clarity																				
3. Exchange information, questions & ideas while recognizing the perspectives of others																				
4. Present perceptions & ideas regarding works of the arts, humanities & sciences																				
5. Perform or produce works in the fine and practical arts				X	X							X	X	X						X
6. Apply communication techniques to the job search & to the workplace				X																
7. Use technological tools to exchange information and ideas				X	X															
8. Organize data, information & ideas into useful forms (including charts, graphs, out-lines) for analysis or presentation																				



**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 2	Standards for Technological Literacy																							
	Standard 9				Standard 10				Standard 11				Standard 12				Standard 13							
	I	J	K	L	I	J	K	L	M	N	O	P	Q	R	M	N	O	P	J	K	L	M		
Goal 2: Acquire the knowledge & skills to communicate effectively within and beyond the classroom																								
1. Plan & make written, oral & visual presentations for a variety of purposes & audiences																								
2. Review & revise communications to improve accuracy & clarity	X																							
3. Exchange information, questions & ideas while recognizing the perspectives of others																								
4. Present perceptions & ideas regarding works of the arts, humanities & sciences																								
5. Perform or produce works in the fine and practical arts																								
6. Apply communication techniques to the job search & to the workplace																								
7. Use technological tools to exchange information and ideas																								



**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards	Standards for Technological Literacy																			
	Standard 1					Standard 2					Standard 3					Standard 4				
	J	K	M	W	X	Y	Z	AA	BB	CC	DD	EE	FF	G	H	I	J	H	I	J
<b>Goal 3:</b> Acquire the knowledge & skills to recognize and solve problems																				
1. Identify problems & define their scope & elements				X	X			X											X	X
2. Develop & apply strategies based on ways others have prevented or solved problems				X															X	
3. Develop & apply strategies based on one's own experience in reventing or solving problems				X															X	
4. Evaluate the processes used in recognizing & solving problems				X															X	
5. Reason inductively from a set of specific facts & deductively from general premises				X					X										X	
6. Examine problems & proposed solutions from multiple perspectives				X														X	X	
7. Evaluate the extent to which a strategy addresses the problem				X														X	X	
8. Assess costs, benefits & other consequences of proposed solutions																		X	X	

**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 3	Standards for Technological Literacy																												
	Standard 5						Standard 6						Standard 7						Standard 8										
	G	H	I	J	K	L	H	I	J	K	L	M	N	O	G	H	I	J	K	L	M	N	O	H	I	J	K		
Goal 3: Acquire the knowledge & skills to recognize and solve problems	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1. Identify problems & define their scope & elements	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2. Develop & apply strategies based on ways others have prevented or solved problems	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3. Develop & apply strategies based on one's own experience in reventing or solving problems	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4. Evaluate the processes used in recognizing & solving problems	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5. Reason inductively from a set of specific facts & deductively from general premises	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6. Examine problems & proposed solutions from multiple perspectives	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7. Evaluate the extent to which a strategy addresses the problem	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8. Assess costs, benefits & other consequences of proposed solutions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X



**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 3	Standards for Technological Literacy																													
	Standard 14						Standard 15						Standard 16						Standard 17						Standard 18					
	K	L	M	K	L	M	N	M	L	K	L	M	N	M	L	K	L	M	N	O	P	Q	J	K	L	M				
<b>Goal 3:</b> Acquire the knowledge & skills to recognize and solve problems																														
1. Identify problems & define their scope & elements																														
2. Develop & apply strategies based on ways others have prevented or solved problems																														
3. Develop & apply strategies based on one's own experience in reventing or solving problems																														
4. Evaluate the processes used in recognizing & solving problems																														
5. Reason inductively from a set of specific facts & deductively from general premises																														
6. Examine problems & proposed solutions from multiple perspectives																														
7. Evaluate the extent to which a strategy addresses the problem																														
8. Assess costs, benefits & other consequences of proposed solutions																														

**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 3	Standards for Technological Literacy													
	Standard 19							Standard 20						
	L	M	N	O	P	Q	R	J	K	L	M	N		
<b>Goal 3:</b> Acquire the knowledge & skills to recognize and solve problems														
1. Identify problems & define their scope & elements	X		X				X	X	X	X	X			
2. Develop & apply strategies based on ways others have prevented or solved problems	X		X				X	X	X	X	X			
3. Develop & apply strategies based on one's own experience in reventing or solving problems	X		X				X	X	X	X	X			
4. Evaluate the processes used in recognizing & solving problems	X		X				X	X	X	X	X			
5. Reason inductively from a set of specific facts & deductively from general premises	X		X				X	X	X	X	X			
6. Examine problems & proposed solutions from multiple perspectives	X		X				X	X	X	X	X			
7. Evaluate the extent to which a strategy addresses the problem	X		X				X	X	X	X	X			
8. Assess costs, benefits & other consequences of proposed solutions	X		X				X	X	X	X	X			



**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 4	Standards for Technological Literacy																											
	Standard 5						Standard 6						Standard 7						Standard 8									
	G	H	I	J	K	L	H	I	J	K	L	M	N	O	G	H	I	J	K	L	M	N	O	H	I	J	K	
<b>Goal 4:</b> Acquire the knowledge & skills to make decisions and act as responsible members of society																												
1. Explain reasoning & identify information used to support decisions	X																											
2. Understand & apply the rights & responsibilities of citizenship in Missouri & the U.S.																												
3. Analyze the duties & responsibilities of individuals in society				X						X																		
4. Recognize & practice honesty & integrity in academic work & in the workplace	X	X		X																								
5. Develop, monitor & revise plans of action to meet deadlines and accomplish goals	X	X																										
6. Identify tasks that require a coordinated effort & work with others to complete those tasks	X																											
7. Identify & apply practices that preserve & enhance the safety & health of self & others	X	X		X																								
8. Explore, prepare for & seek educational & job opportunities	X																											

**Standards for Technological Literacy - Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 4	Standards for Technological Literacy																							
	Standard 9				Standard 10				Standard 11				Standard 12				Standard 13							
	I	J	K	L	I	J	K	L	M	N	O	P	Q	R	M	N	O	P	J	K	L	M		
<b>Goal 4:</b> Acquire the knowledge & skills to make decisions and act as responsible members of society																								
1. Explain reasoning & identify information used to support decisions									X															
2. Understand & apply the rights & responsibilities of citizenship in Missouri & the U.S.																								
3. Analyze the duties & responsibilities of individuals in society																								
4. Recognize & practice honesty & integrity in academic work & in the workplace																								
5. Develop, monitor & revise plans of action to meet deadlines and accomplish goals																								
6. Identify tasks that require a coordinated effort & work with others to complete those tasks																								
7. Identify & apply practices that preserve & enhance the safety & health of self & others																								
8. Explore, prepare for & seek educational & job opportunities																								

**Standards for Technological Literacy - Missouri Show-Me Standards Crosswalk Grades 9 - 12**

Show-Me Standards Goal 4	Standards for Technological Literacy																													
	Standard 14						Standard 15						Standard 16						Standard 17						Standard 18					
	K	L	M	K	L	M	N	M	L	K	M	N	L	M	K	L	M	N	O	P	Q	J	K	L	M					
<b>Goal 4:</b> Acquire the knowledge & skills to make decisions and act as responsible members of society																														
1. Explain reasoning & identify information used to support decisions																														
2. Understand & apply the rights & responsibilities of citizenship in Missouri & the U.S.																														
3. Analyze the duties & responsibilities of individuals in society																														
4. Recognize & practice honesty & integrity in academic work & in the workplace																														
5. Develop, monitor & revise plans of action to meet deadlines and accomplish goals																														
6. Identify tasks that require a coordinated effort & work with others to complete those tasks																														
7. Identify & apply practices that preserve & enhance the safety & health of self & others																														
8. Explore, prepare for & seek educational & job opportunities																														







## **Chapter 3 – Elementary School Technology and Engineering**

## Chapter 3 Elementary Technology and Engineering

### 1 – Introduction

This chapter contains the materials from the **ITEA- STEM Center for Teaching and Learning™**, Technology Starters: A Standards-Based Guide (ITEA 2002) for grades K-5. This document was developed by and for the STEM Center Consortium for use by its members. Missouri has been a consortium member since the 2000-2001 school year, the year that this product was developed, giving us the rights to utilize, copy and distribute this product to our teachers. The Technology Starters Guide contains 180 pages.

These guides are available by visiting the **ITEA- STEM Center for Teaching and Learning™, Engineering by Design™** consortium website at

<http://www.iteaconnect.org/EbD/CATTS/cattsconsortium.htm> and clicking on the Missouri Access

button -



### 2 – Why Should Elementary Students Study Technology and Engineering?

We seem to have no problem beginning the formal primary education of our nation's youth with core subjects such as language arts and mathematics. National conferences, field research, state task force reports, and local curriculum reform efforts acknowledge that a study of the most pervasive and powerful cultural force, technology, should be a regular and significant subject for study in all grades in our nation's schools. This new "core" subject is essential to preparing students for life in a world defined by technology and innovation.

Imagine a world without the wonderful innovations that are found in all areas of daily life: in transportation, health care, communication, recreation, and careers. Students who develop technological literacy beginning in the early grades will have the thinking skills and basic understandings necessary to use and manage technology responsibly and to make wise decisions concerning new innovations.

Technology is not an add-on subject in the primary grades. Rather, the study of technology is an integral part of the elementary curriculum. At this level, technology provides the theme or context for studying other subjects. For example, studying life in the colonial period of American history includes content concerning what kinds of houses people lived in and how news and events were communicated between towns and across the ocean to Europe. The early settlers devised systems for transportation and developed tools and irrigation systems for growing crops. An activity incorporating the study of technology might engage students in designing and making models of colonial homes and communities, designing and creating kitchen utensils out of materials available at that time, or assembling a medical kit with mock supplies that would have been used at the time. Students are curious about how people lived in different contexts; technology provides an exciting context for studying and experiencing ways that people have adapted to new places and improved upon what was already there.

### 3 – Course Content, Unit Descriptions, and Resources

There are a variety of options available to schools and they are copyrighted and require membership and/or contractual agreement between the local educational authority and the International Technology Education Association.

#### **Standards-Based Resources that provide Strategic Advantages for Elementary Students: (ITEA)**

##### Innovation, Innovation, and Inquiry (I3)

Invention, Innovation, and Inquiry units for Technological Literacy, Grades 5-6, was funded by the National Science Foundation. This project is so named because invention and innovation are the hallmarks

of technological thinking and action. Each unit has standards-based content, suggested teaching approaches, and detailed learning activities, including brainstorming, visualizing, testing, refining, and assessing technological design. Students will learn how inventions, innovations, and systems are created and how technology becomes part of their lives. The following units are available and contain teacher background information, handouts, transparency masters, and a student packet that are designed to integrate mathematics and science with technology and take 8 to 10 days:

Invention: The Invention Crusade

Students develop an idea for an invention by designing and constructing a working model or prototype of a gadget that helps a small child to do a household task.

Innovation: Inches, Feet, and Hands

Students use the engineering design process to design and develop and improve a product that is used by the human hand.

Communication: Communicating School Spirit

Students examine communication processes and mediums by designing, developing, and implementing different types of commercial projects promoting school spirit.

Transportation: Across the United States

Students investigate the systems of transportation and how transportation has impacted the United States. Then they apply their learning by designing a transportation vehicle.

Inquiry: The Ultimate School Bag

Students use inquiry skills to redesign a school bag and construct a model of the “Ultimate School Bag”.

Manufacturing: The Fudgeville Crisis

Students explore food preservation and packaging as their companies mass-produce and package “fudge” for a fudge festival.

Construction: Beaming Support

Students act as structural engineers and design and construct at least two laminated paper beams—testing, evaluating, and redesigning their beams for maximum strength.

Power and Energy: The Whispers of Willing Wind

Students gain an understanding of wind energy and power as they construct a device that captures wind energy and converts it to electricity.

Design: Toying with Technology

Students explore two-dimensional (2-D) and three-dimensional (3-D) visualization processes and medium by designing, developing, and building toys that solve a given problem.

Technological Systems: Creating Mechanical Toys

Students investigate two mechanical devices—pneumatics and linkage mechanisms—and design a toy that uses both to create movement.

These resources and more are available online through the ITEA web publications resource page at:

<http://www.iteaconnect.org/Membership/elementaryteacher.htm>

## A recommended resource for Elementary Teachers



The Virginia Children's Engineering Council (VCEC) is an excellent resource and it is dedicated to developing design and technology instructional material, and providing local, regional and statewide in-service opportunities for educators at grades K-5 throughout Virginia. The in-service programs help teachers ensure that children develop an understanding of how to use, create, control, and assess technology. These instructional experiences are provided in a design, critical thinking, and problem solving context. They undergird attainment of selected Standards of Learning in English, mathematics, science, and history and social science



## **Chapter 4 – Middle School Technology and Engineering**

## Chapter 4 Middle School Technology and Engineering

### 1 – Introduction

The mission of technology and engineering at the middle school level is to provide students with experiences in technology. In technology and engineering, students investigate how things work and design solutions to problems using tools, materials, and other resources. These activities help students assess their personal interests and talents and then relate them to a wide range of careers and educational opportunities.

### 2 – Course Titles and Descriptions

There are two program options available to schools and both are copyrighted and require a contractual agreement between the local educational authority and the program entities listed with each respectively and both are eligible for Career Education Program Approval.

#### Option # 1 – Engineering byDesign™

##### Mission

We live in a technological world. Living in the twenty-first century requires much more from every individual than a basic ability to read, write, and perform simple mathematics. Technology affects every aspect of our lives, from enabling citizens to perform routine tasks to requiring that they be able to make responsible, informed decisions that affect individuals, our society, and the environment.

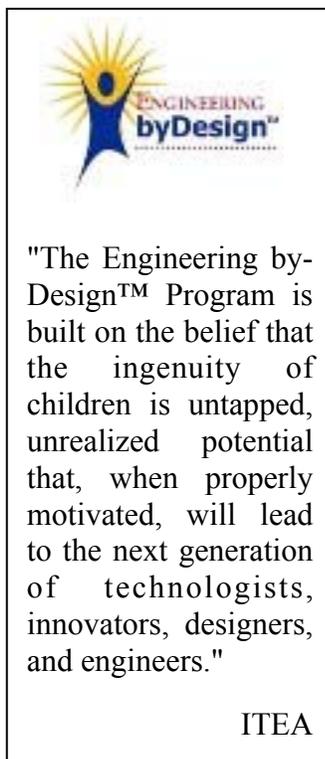
Citizens of today must have a basic understanding of how technology affects their world and how they exist both within and around technology. Technological literacy is fundamentally important to all students. Technological processes have become so complex that the community and schools collaborate to provide a quality technology program that prepares students for a changing technological world that is progressively more dependent on an informed, technologically literate citizenry.

##### Vision

The ITEA model technology program is committed to providing technological study in facilities that are safe and facilitate creativity, enabling all students to meet local, state, and national technological literacy standards. Students are prepared to engage in additional technological study in the high school years and beyond. Students will be prepared with knowledge and abilities to help them become informed, successful citizens who are able to make sense of the world in which they live. The technology program also enables students to take advantage of the technological resources in their own community.

##### Goals

- ◆ Provide a standards-based K-12 program that ensures that all students are technologically literate.
- ◆ Provide opportunities for all students without regard to gender or ethnic origin.
- ◆ Provide clear standards and expectations for increasing student achievement in math, science, and technology.
- ◆ Provide leadership and support that will produce continuous improvement and innovation in the program.



- ◆ Restore America's status as the leader in innovation. Provide a program that constructs learning from a very early age and culminates in a capstone experience that leads students to become the next generation of technologists, innovators, designers, and engineers.

### Organizing Principles

The EbD™ program is organized around seven principles. These principles are very large concepts that identify major content organizers for the program. In order of importance, the seven organizing principles are:

- ◆ Engineering through design improves life.
- ◆ Technology has and continues to affect everyday life.
- ◆ Technology drives invention and innovation and is a thinking and doing process.
- ◆ Technologies are combined to make technological systems.
- ◆ Technology creates issues that change the way people live and interact.
- ◆ Technology impacts society and must be assessed to determine if it is good or bad..
- ◆ Technology is the basis for improving on the past and creating the future.

The curriculum for this option is provided by **ITEA- STEMϕCenter for Teaching and Learning™**, and should be coordinated through the Missouri EbD™ State Leader. EbD™ is a copyright protected program that can only be used by contractual agreement between the local educational authority and **ITEA- STEMϕCTL**. These guides are available upon request by visiting the **STEMϕCenter for Teaching and Learning™, Engineering byDesign™** consortium website at <http://www.iteaconnect.org/EbD/CATTS/cattsconsortium.htm> and clicking on the Missouri Access button –



**Course sequence** follows the EbD™ format:

#### Innovation and Innovations – CD (100423)

Innovations, or commercially produced inventions, affect us personally, socially, and economically. Students participate in engineering design activities to understand how criteria, constraints, and processes affect designs. Brainstorming, visualizing, modeling, constructing, testing, and refining designs provide skills in communicating design information and reporting results. This class is suited for 18 weeks.

#### Exploring Technology – CD (100424)

Students develop an understanding of the progression and scope of technology through exploratory experiences. In group and individual activities, students experience ways in which technological knowledge and processes contribute to effective designs and solutions to technological problems. This course may be six weeks or nine weeks in duration.

#### Technological Systems – CD (100425)

Students become acquainted with content and processes associated with basic technological systems. The design, development, and relationships of different systems are explored. Students apply systems concepts to design and problem-solving activities related to transportation, information, energy/power, biotechnology, and other technological systems. Laboratory activities engage students in constructing, using, and assessing technological systems. This course may be 18 weeks or 36 weeks in duration.

## Option # 2 – Project Lead The Way© – Engineering

### Mission

Project Lead The Way's (PLTW's) mission is to ensure that America succeeds in the increasingly high-tech and high-skill global economy, by partnering with middle schools and high schools to prepare students to become the most innovative and productive in the world.



### Overview

PLTW© is the nation's leading provider of rigorous and innovative Science, Technology, Engineering and Math (STEM) education for middle schools and high schools. PLTW's comprehensive curriculum, which is collaboratively developed by PLTW© teachers, University educators, engineering and biomedical professionals, and school administrators, emphasizes critical thinking, creativity, innovation and real-world problem solving. The hands-on, project-based program engages students on multiple levels, exposes them to areas of study that they typically do not pursue, and provides them with a foundation and proven path to college and career success in STEM related fields.

**The curriculum** for this option is provided by Project Lead the Way© (PLTW©) and should be coordinated through the Missouri PLTW© State Leader. PLTW© is a copyright protected program that can only be used by contractual agreement between the local educational authority and PLTW©. For more information about the PLTW© engineering curriculum go to <http://www.pltw.org/>. The Engineering program is eligible for Career Education program approval.

### Gateway to Technology© – CD (100403)

The purpose of this course is to expose students to a broad overview of the field of technology and its related processes. Because engineers use mathematics, science, and technology to solve problems, the course has been designed to be "activity oriented." It incorporates four units, each designed to be taught in a period of ten weeks. Each unit is an independent unit, developed specifically for the student's age and comprehension level. It is recommended that they be taught in the order shown in the outline below:

### **3 – Curriculum Thrust: Exploration & Engagement**

Technology and Engineering programs in grades 6-8 strengthen what students learn about the processes that apply to the design, development, and use of technological products and systems. Students will have opportunities to explore and be engaged in activities that allow them to produce models and develop real technological products, systems, and environments.

The study of technology lends itself as a natural curriculum integrator with other fields of study. This advantage, along with the pleasure early adolescents take in active learning, emphasizes the need for a well-planned and developed technology and engineering program. At the middle school level, the study of technology should be an instructional sequence that builds on experiences and knowledge developed in K-5, and it should extend the development to be a foundation for future courses at higher grade levels.

### **4 – Nature of the Learner**

The currently-accepted vision of children as active, constructive thinkers who develop in the context of their social world as put forth by such theorists as Vygotsky and Mueller provide the basis for many of the methods discussed and related in this chapter. Contemporary research on the brain, multiple intelligences, and learning styles have added to the discussion and understanding of how children learn.

Middle level students are moving between childhood and early adulthood. Physical growth and change is significant as girls tend to mature earlier than boys do. They are curious and want to be a part of the adult world. They are interested in learning and are developing the ability to do things and make things as adults do. Yet, they are developing independence and each student will demonstrate his or her own

learning and expression styles. Influence of peers builds during this time and the middle level student may be less likely to accept adult guidance. These students are active and thrive on social contact. The need for approval and self-worth development is high.

Using opportunities that allow students to work in teams or small groups provides them with interactions that are important for social development. Small group activities may be particularly effective in building students' self-esteem by enabling boys and girls to have success with new and perplexing tasks. Building on knowledge and abilities learned in previous grades, middle level students should be encouraged to approach technological programs without fear. It is important to realize that middle level students learn independently and out of curiosity. They should be encouraged to be in control of their own learning by refining their abilities and developing and using decision-making and critical thinking skills.

Teachers are encouraged to review works by leading developmentalists William Damon, Howard Gardner, David Henry Feldman, and Deanna Kuhn for helpful suggestions on incorporating the current views of child development, such as multiple intelligences, creativity, and how to apply basic research in an educational setting.

## **5 – Transforming the Middle School Education**

The 1997 national report, *Turning Points: Preparing American Youth for the 21st Century*, makes the following recommendations for transforming middle schools. Technology and engineering teachers can contribute to the improvement of their middle schools by following these recommendations:

- ◆ Create small, personalized communities for learning.
- ◆ Integrate content in technology and engineering with core academic programs.
- ◆ Ensure success for all students.
- ◆ Be involved in pedagogical, management, and budget decisions.
- ◆ Obtain training or continuing education for teaching young adolescents
- ◆ Foster health and safety
- ◆ Re-engage families in the education of students.
- ◆ Connect middle schools with communities.

(Adapted from Lipsitz, et. al., 1997).

## **6 – Career and Educational Exploration**

Careers and career information are topics of critical importance to the future of all students. Therefore, it is important for all students to have opportunities for career and educational exploration throughout the learning process. Career information can help students explore some of the opportunities they may choose from in the future. At the middle school level, students may make tentative career choices that in turn will enable them to select classes and educational programs that meet their aspirations. Because technology is a part of our everyday life, most careers will require students to understand and be able to use technology.

*Career exploration* and *career decision-making* are terms that reflect how career information is shared in many school settings, how careers are discussed, and how students learn about a variety of careers.

Career Exploration is a term used to describe the middle school experiences that enable students to get a glimpse of a variety of careers and school subjects that prepare people for those careers.

Career Decision-Making is a process by which an individual becomes aware of careers that are of interest. Decisions are made of one as one learns more about his/her own abilities, aptitudes, and interests. This process continues throughout life.

## 7 – Changing Emphasis in Technology and Engineering

The chart below provides a guide on the change in emphasis in the study of technology and how this may be implemented in the technology and engineering laboratory-classroom. It is not to imply that those topics listed on the Less Emphasis side should no longer be discussed or taught. It means that there should be less emphasis placed on them in order to provide for the recommendations listed on the More Emphasis side in figure 4-1.

<b>Figure 4-1 Changing Emphasis in Technology and Engineering</b>	
Less Emphasis On:	More Emphasis On:
Knowing technical details and parts of tools	Understanding systems and their interrelated parts
Activities that are fun	Selecting fun activities that reinforce and teach content
Processes and skills to complete a project	Designing and planning before making
Working alone	Working in groups or teams
Teacher as information expert	Teacher as facilitator of student learning
Management of materials and equipment	Management of ideas and information
Student communicates to teacher	Student presents information to classes
Tests as the only assessment	Self and team evaluation and reflection
Right or wrong answers	Open-ended, innovative, creative solutions that allow for opportunities to take risks and discover what works

## 8 – Documenting Student Achievement of Content Standards across Grade Levels

In order to completely address students' technological literacy and effectively document their achievement, teachers will have to articulate the Standards for Technological Literacy with their curriculum. They will need to develop activities beyond those presented in the next chapter in a way that will allow their students to address all twenty standards and their related benchmarks.

While this curriculum development process will be time consuming, it will not be as difficult as documenting student achievement across the standards from year to year.

While using portfolios is an obvious long-term solution, a matrix can be used to document that a particular benchmark has been addressed. The teacher passes the checklist to the student's next teacher as the student matriculates through the school system. This process will be most easily accomplished with a computer database.

For more information on transforming the learning environment, see Lipsitz, Jackson, and Austin (1997). For more information on how students learn see Damon (1991); and Holt (1983).

## 9 – Methods: Strategies for Standards-based Instruction

This section contains several methods for teaching middle level students. Since students at this age level have unique developmental needs, the technology and engineering teacher should choose and adapt these activities according to their teaching styles and students' learning styles.

### Method 1 – Using Design Briefs to Challenge Problem Solvers

The importance of problem solving cannot be overemphasized. Students need to be problem solvers at every age, both in school and at home. Teachers may use design briefs to challenge and encourage students to think, create, and solve technological problems. When students first begin using design briefs, short paragraphs should be used to engage them in creative problem solving. As students become accustomed to using simple design briefs, more complex and detailed design briefs that do not have one right answer should be developed to challenge them to be more creative and to use higher-level thinking and problem-solving skills. Also, as students become more advanced in using design briefs, they should be challenged to develop and write their own.

#### Definitions

Design Brief: A written plan that identifies the problem to be solved. It is used to help students think of all aspects of the problem before starting to work on improving and/or developing a way of doing something. The design brief describes the problem, identifies the criteria, and lists the constraints students will face in creating a solution.

Constraint: Side effect or limit within the design process.

Criterion: The desired element or feature of a product or system.

Problem Solving: The logical process of using prior knowledge, asking questions, testing and trying ideas in order to solve a problem, to meet a need or want, or to improve a process or product.

Design Process: A problem-solving strategy, with criteria and constraints, used to develop many possible solutions to solve a problem or satisfy human needs and wants. The design process is a general developmental method that is iterative (not linear).

### Getting Students Started with Design Briefs

1. Select or write short problem statements (design briefs) that incorporate a concept being discussed in the class. Many well-written design briefs may be found in *The Technology Teacher*, text-books, and instructional materials. However, it will also be necessary for you to write your own for a specific purpose.

### Content Examples:

- ◆ Selecting and using appropriate tools and materials for a given purpose.
  - ◆ Working together in pairs or groups.
  - ◆ Using sketches, schematics, and models to communicate.
  - ◆ Developing safe ways to transform organic and inorganic wastes into usable resources.
  - ◆ Designing a product or system to meet a need or want or to solve a problem.
  - ◆ Using symbols, logos, or language to communicate.
2. Give a previously prepared design brief to each group or use a transparency, computer presentation software, or blackboard to display it.
  3. Discuss with students the definitions of constraint and criterion and why constraints and criteria are identified. Help them determine how constraints and criteria affect a design brief.
  4. Provide the specified materials, supplies, or tools needed to complete the challenge in the design brief. Remind students of the limitations in using resources stated in the design brief.
  5. Have students work together in order to create and develop solutions to the problem statement.
  6. To aid students in developing their creative-thinking and problem-solving skills, illustrate the many steps they may follow in the design process. Remind students the steps are iterative and, therefore, do not have to be followed in any particular order and each step may be repeated as many times as needed.

### **General Steps in the Design Process:**

- ◆ Describe the problem and learn more about it. Specify goals.
  - ◆ Generate ideas to solve the problem or meet a need or want.
  - ◆ Identify criteria and constraints.
  - ◆ Consider alternatives.
  - ◆ Select one idea.
  - ◆ Plan, prototype, model, and develop the idea.
  - ◆ Test and evaluate the product or system.
  - ◆ Make adjustments and revisions if necessary.
  - ◆ Communicate solution and design process with others.
7. After completing this activity, ask each group to explain their solution(s), demonstrate their solution(s), evaluate their solution(s), and discuss the procedures they used in solving the design brief.

### **Sample Design Brief Statements**

These short design brief statements may be adapted and used to motivate students.

1. Using any item(s) that you would normally dispose of, create an object that would be useful around your home. Work by yourself or with one other person in this class. Be prepared to discuss your object with you classmates.
2. In groups of three or four, design a fixed-route transportation system that will transport goods (clothespins) between two points in the laboratory-classroom. Use only the materials in the bag that you are given. You may only use your hands to touch the system before the goods have departed and after they have arrived at the destination. Test your system in order to evaluate the results of your design and, if necessary, to revise or fix it to work better.
3. Using a flashlight, cardboard, tape and fasteners, develop a signaling device for sending messages across the laboratory-classroom. The device must be able to turn the light beam into coded information that can be read by another student who is not in your group.

- Using materials provided by the teacher, design and construct a catapult that will transport a large marshmallow a specified distance. Teams of two or three students will work together to make one catapult. Explain how your device works, demonstrate its use, and record distance achieved.

### **Components of a Design Brief**

Context or Situation: This part of a design brief describes a real-life situation where a problem occurs or where a want or need can be met. The context may be from broad areas of student life, such as school, community, home, or world. Other practical situations may be selected from student involvement in athletics, transportation, recreation, family, or fitness.

Need or Challenge: The challenge statement gives a clear focus to the design problem. It explains to the student how the needs of a situation may be met without describing how to solve the problem.

Objectives: The objectives of a design brief are selected by the teacher. In most cases, the objectives come directly from Standards for Technological Literacy and the curriculum. The objectives may be modified by the teacher to meet the individual needs of a group or individual students.

Criteria: The criteria relate to the overall desired goals of the design brief and should be measurable objectives that can be attainable in a reasonable time. Together with constraints of a problem, criteria can be written into a design brief as a section called Requirements.

Constraints: The limitations that are imposed on problem solving or designing. The limitations may be caused by availability of specific equipment, such as computers, space, materials, and human capabilities. Together with the criteria of a problem, constraints can be written into a design brief as a section called Requirements.

Resources: The things needed to get a job done. In a technological system, the basic resources are: energy, capital, information, tools and machines, materials, people, and time.

Evaluation or Testing: Evaluation or testing is an important part of the problem-solving and design process. The evaluation statement provides the guidelines to help students determine if their solution solves the problem and meets the criteria of the design brief.

Assessment: Teachers may use the assessment to indicate how students will be assessed on what they have learned through the completion of the project. Criteria for assessment is based on the Standards that relate directly back to the objectives of the lesson selected by the teacher.

### **Helping Students Write Design Briefs**

- Students should be encouraged to write their own design briefs to guide them in solving problems they selected.
- Encourage students to do research or read about the topic before writing the specifications for the problem in the design brief.
- Provide a handout that depicts the components of a design brief or have students refer to earlier samples.
- Assist students with writing and selecting appropriate objectives, constraints, criteria, and assessment statements.

### **Method 2 – Teaching Students to Assess the Impact of Technology**

#### **Overview**

All around us, we are aware of things that do not turn out the way they should. Why did the new business close after only a few months of operation? Was it because of poor planning? Why is the local chemical company polluting the river system? Why is the number of traffic fatalities on our roads continuing to rise? In order to find the answer to these and other similar questions, assessment techniques must be used. Assessment is a critical part of the study of technology, and therefore is both a method and

content.

## **Definitions**

**Technological Assessment:** A process of evaluating new technological items to predict the good and bad effects that may result. This process of thinking will lead to the identification of second, third, and fourth effects that may affect society more deeply than the primary effects. Using technological assessment leads to socially responsible decision-making.

**Impact of Technology:** The results of technological change. These outcomes may affect our society in economic, cultural, social, political, environmental, or a combination of many of these ways. The impact of technology can be observed in history, identified in the present day, and predicted for the future.

**Science, Technology, and Society:** This technique allows students to take an interdisciplinary approach when examining the concepts and processes of science and technology and relating the effects of each on society. This study helps lead to an informed citizenry capable of making responsible and social decisions.

## **Getting Started**

At the middle level, it works best to have students find examples of technology around their home or community that illustrate the desired and undesired effects of technological development. You can have your students cut articles and pictures from the newspaper, do research in the libraries, or find information on the World Wide Web. Students can then share their information with their classmates and explain how the technological development impacted the environment, society, culture, economy, or various other factors.

Students may report their findings in portfolio presentations, descriptive reports, multimedia presentations, or oral presentations. They should be guided to ask themselves questions that foster thinking about the product or system, its stated purpose, and its actual impact. Asking the right questions is an art that develops over time and with numerous opportunities to explore and acquire new information. When you use this method of instruction for the first time, help students prepare a list of questions that will help them understand and to begin to guide their own thinking. In addition, provide plenty of time for students to discuss their questions and allow students to prepare or give thoughtful answers. Have students make a written record of their considerations, observations, responses, and conclusions.

The following sample questions will help guide you as you incorporate this method into helping students understand more about the nature of technology through assessment.

- ◆ What is the product or system? What can you tell me about it?
- ◆ How is the product or system used? Is its current use what it was originally intended for?
- ◆ Where can you find needed information about the products or systems, individuals, society, and the environment? Does it have potential harm if misused, not maintained, or ignored?
- ◆ What would happen if the product or system were no longer available or was worn out?
- ◆ What is the product's or system's strengths and weaknesses? How has it helped individuals in society, or the environment?
- ◆ Is the product or system necessary?
- ◆ Is the product or system designed to aid all users, or must special adjustments be made to help someone who may have a disability or handicap? If adjustments must be made, would making the adjustments cause unexpected hardships or unintended misuse? If so, would a new design need to be made in order to address the issue more effectively?
- ◆ How many kinds of technological processes are used in order to develop this product or system?
- ◆ Should the product or system be made just because it can be made? What is the economic impact of the product or system if it is made or is not made?

Students may want to expand on their presentations. One way is by showing how they can predict the long-term results of a technological development prior to making and selling a new product. This assessment can be accomplished through mathematical measurement and scientific reasoning. This requires students understanding data collection, statistical questioning, and how to draw conclusions.

Providing students with opportunities to discuss their findings, determine the value and importance of a product or system, and draw conclusions on their discussions will aid them as they begin to learn that assessment is an on-going process that takes many different forms at varied levels of difficulty. By teaching students these assessment techniques, they will one day have the skills to be responsible decision-makers in deciding what products, systems, and technologies are introduced or modified for future use.

### **Basic Steps for Assessment**

1. Describe the technological development they will assess and begin learning more about it.
2. Generate or brainstorm possible impacts, both positive and negative, of using this product or system. This should include social, economic, and environmental effects.
3. Analyze the above list and identify options to deal with or avoid the problem.
4. Make predictions based on the alternatives.
5. Communicate the benefits of the technological assessment.

### **Method 3 – Cooperative Learning, Teamwork, and Leadership**

#### **Overview**

Group work or teamwork is an effective strategy for helping students learn more about technology and to accomplish the objectives of a lesson while at the same time, they learn the importance of working together in order to reach a common goal. Students will gain more knowledge and skills working together than they will work individually. Providing students with numerous opportunities to work together will help them increase their communication skills, organizational processes, and confidence in working with others.

When cooperative learning is first introduced into the laboratory-classroom environment, sometimes confusion occurs between teacher and students about what is expected when working in groups. Cooperative learning is more than simply sitting in a group and solving a problem in the least amount of time or allowing one person to do all of the work while the others sit back and watch. Cooperative learning is the interaction of students through discussing the information or problem being investigated. This means that students should not only actively discuss ideas, but also help and share solutions so that all students should be instructed on how to help each other through positive promotion of each individual's capabilities. Encouraging all students to excel will help students realize their own strengths and begin to build upon them.

As important as learning to work together is viewed in schools today, learning to self-assess how well students work together is essential to developing skills that will help them in future endeavors. Students need to determine how effectively they work together and if they are using appropriate interpersonal skills. Asking questions of themselves as they are working together will help them guide their own thinking and make adjustments when situations arise in different environments. Most importantly, students will learn to hold themselves, as well as their peers, accountable for their share of the work and realize that together they can all learn.

#### **Definitions**

Cooperative Learning: This type of learning is based on the notion that students can learn from each other by coordinating efforts in a format that promotes the exchange of dialogue and ideas. Each member of the small learning group has a role or responsibility to share and contribute to the other members' and the groups' progress.

**Teamwork:** This process helps students work and learn together. Small groups or teams encourage students to share knowledge and skills while completing both short and long assignments. This is similar to the professional world, such as a project team consisting of engineers who bring different expertise to the group.

**Leadership:** This ability enables people to influence others. Leading in a group involves planning, organizing, communication, managing, and cooperating.

### **Getting Started**

1. Discuss the benefits of working cooperatively. Describe organizations with leaders and followers. Discuss the attributes of an effective leader and cooperative participants.
2. Arrange students into small groups of three or four students based on the type of activity and the type of students needed in the group.
3. Have each group select a leader and recorder and assign related jobs for the remaining members. Remind students that each member will have a specific job, but all members are responsible for the group results.
4. When time permits, have teams prepare a team name, logo, and slogan as a way to learn cooperation and show group identity.
5. Hand out design briefs or assignments to each group and encourage students to read and discuss the challenge.
6. Provide guidance to the group by prompting with questions without giving answers. Provide time to mingle with the groups and quietly observe that each member of a group is participating in the dialogue and that the work is not being dominated by only a few members.
7. Throughout the year, rotate groups in order to improve group dynamics, increase learning, and develop new leadership.

### **Student Rules and Expectations**

- ◆ Stay with your team and cooperate.
- ◆ Everyone must participate, share, and speak up.
- ◆ Respect others, yourself, teacher, and materials.
- ◆ Elect leaders to fill specific roles and responsibilities.
- ◆ Manage time, resources, and people carefully.
- ◆ Speak or report on the progress of your group.

### **Method 4 – Assisting Students with Special Needs**

#### **Overview**

There are a variety of techniques that teachers can use to help students with special needs function successfully in technology and engineering classes. With proper laboratory-classroom facilities and well-trained teacher, students with special needs can become active and successful participants in technology and engineering classes.

#### **Definitions**

**Learning Disability:** A disorder in one or more of the basic psychological processes involved in the understanding or use of spoken or written language, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations. Causes may be perceptual handicaps, brain injury, brain dysfunction, dyslexia, and developmental aphasia.

**Emotionally Disturbed:** A type of disorder where observed behaviors deviate from the average or typical. Students with emotional or behavioral disabilities exhibit undesirable actions or feelings over a

long period of time which adversely affects performance. Symptoms include an inability to get along with their peers as well as hyperactivity. This is also known as behavior disorder.

Mental Disorder: Disorders marked by social deviance, personality disturbances, and emotional turmoil.

### **Involvement in Individualized Education Program Planning**

In 1975, the Education for All Handicapped Children Act (PL 94-142) was passed by Congress to provide all children with a free and appropriate education. One of the main provisions of the Public Law 94-142 was the introduction of the individualized education program or plan (IEP) for each special needs student. An IEP allows parents, teachers and students to plan the best individualized instruction in order to meet the specific needs of the student. The plan typically explains special services that are required for the student to help him or her meet the requirements of the course. For example, if a student has a reading deficiency, accommodations for taking tests may be provided, such as tests that are not timed or providing a test-reader who will read the test to the student who then respond to the question on their paper.

The IEP has proven successful in many school districts. Some school districts are considering or have implemented the use of IEP for all students, not just those with documented special needs. The IEP process alerts the teacher to the student's present level of educational performance and goals or services that need to be provided. Teachers can use the IEP as a guide to learn how to modify their laboratory-classroom and teaching styles in order to meet the needs of all of their students.

### **Techniques for Diverse Learning Styles**

- ◆ Use both visual and verbal teaching techniques.
- ◆ Make lessons concrete with models, handouts, and sample artifacts.
- ◆ Give immediate feedback for performance to reinforce appropriate behavior.
- ◆ Offer individualized instruction and group or peer assistance.
- ◆ Organize activities to ensure successful learning and projects. Keep steps simple.
- ◆ Challenge students to their optimal level.
- ◆ Repeat important concepts.
- ◆ Collaborate with special education teachers in subject matter and instructional procedures.
- ◆ Facilitate the participation of all students in group, class, and club activities so they perceive themselves as part of the team.
- ◆ Include both technical and career information as part of laboratory activities.

### **Method 5 – Enhancing Creative Thinking**

#### **Overview**

Everyone needs great ideas. Whether they come from a teacher, parent, professional, or student, creative ideas lead to success. Ideas come when a person with a creative mind is concerned about a problem, situation, crisis, or goal. Creation is fun because it is play. It allows a person to manipulate objects and ideas in order to come up with something new.

Learning to be creative takes time and there is no quick, simple technique. An environment that allows students to freely express their emotions, thoughts, and ideas is central to the development of creative thinking. Also, students must be provided with the needed feedback that it is okay to express their feelings, to try out new ideas, and to experiment, test, or explore. Teachers need to recognize when they should step in and provide more leadership and structure to the laboratory-classroom environment. Proper guidance, when necessary, helps students get started on a creative activity, get unstuck, or have confidence in their decisions. This encouragement will then enable students to be willing to try out their ideas and to solve challenging problems without the fear of failure.

It is vital to help students understand that the failure of an idea is not the end, but the beginning for many new discoveries. This concept is essential for them to be willing to work on a problem until they are able to solve it or to realize the solution may not be available with the information that is presently available. One way to reinforce this concept is to share with students how inventors of the past are often quoted about their failures. Students should also begin to realize that it is not how fast they are able to solve a problem or develop a solution that is important, rather it is that they are learning the process of creative thinking. It is important to stress to students that when a failure occurs, it is not that the idea was bad, rather, it is a chance to learn what does not work and perhaps open the door to a better idea.

Encouragement, freedom of expression, curiosity, exploration, questioning, daydreaming, and appreciation for what is tried all bring out the natural creative expressions for many students. In addition to a creative, friendly environment, students still need structure and clarity of purpose. Therefore, it is important to state clear expectations – rules, deadlines, and feedback. Allowing students to help set the expectations provides them with a feeling of ownership and the confidence that the teacher and the environment promote creative thinking.

### **Definitions**

Invention: The creation of a completely new idea, device, or different way of doing something.

Innovation: The improvement of an existing idea, device, or way of doing something in a creative or different way.

Creativity: The ability to look at the same thing as everyone else but to see it differently.

### **Creating an Idea-Friendly Laboratory-Classroom**

- ◆ Allow students the inner freedom to consider new ideas and possibilities. Take away the obstacles that prevent students from having the freedom to be creative and to dream.
- ◆ Establish a creative laboratory-classroom environment where students are encouraged to think differently and create new solutions. For example, you can provide tables for group planning and brainstorming and signs and posters that encourage creativity. You can also frequently rotate students into new groups and topics to encourage the flowing of new ideas.
- ◆ Before students can begin to solve a problem, he or she must know what the problem is. You can clarify the problem by writing down words or descriptors of the problems. Some words will trigger other words about the problem until students create an idea map, cluster, or outline that clearly defines the problem.
- ◆ Teach students the art of brainstorming. Use it frequently as a way to involve the entire class in a discussion or as a tool for small groups to use as a way to think up creative ideas.
- ◆ Avoid or diffuse phrases that kill creativity. “Killer phrases” that students may utter, such as “I can’t do this,” “This looks stupid,” and “I can’t believe that is your solution,” may come from self-doubt or the fear of looking stupid. Other phrases may come from classmates who want to criticize their peers. These comments must be immediately recognized, corrected, and perhaps redirected into new ideas so that students will not be afraid to share their ideas with the group.
- ◆ Illustrate creative thinking using various methods, such as envisioning the problem to be solved, thinking in opposite directions, or offering a statement that compares one problem to another.
- ◆ After students have spent time brainstorming, evaluate the ideas. Describe the positive, interesting, and negative factors of each one. Allow new ideas to flow from this exercise.
- ◆ Remind students that the best way to develop great ideas is to look at lots of other people’s ideas and then evaluate them.

## Method 6-Sharing, Reporting, and Recording Information

### Overview

An effective method teachers may use to assess students' performances is to have the students talk about or share information about their model, project, or solution. Design portfolios or logs are used to record ideas and steps in the problem-solving process and to provide a means to share what they are learning with others. This method may be used on a regular basis as a means to provide students with the opportunity to gain confidence and to learn how to effectively communicate and how to make presentations.

### Definitions

Sharing: Students give short talks about what they are learning about or doing in class. They may offer advice to other students during formal seminars or as a part of teamwork and cooperative learning.

Oral Presentation: Takes place at the completion of an individual or group project. This report may include the use of visuals, such as illustrations, photographs, computer-generated images, models, posters, flip charts, or slides.

Portfolio: A systematic and organized collection of a student's work that includes results of research, successful and less successful ideas, notes on procedures, and data collected. The design portfolio or design log may also be used to demonstrate the cumulative learning process of a student over a unit of study, grading period, or entire course of study.

### Getting Started

- ◆ Call on students to tell the class what they are making or to describe significant progress they have made or something they have learned.
- ◆ Arrange progress seminars where each student (or group) gives an oral report on progress, problems, and recent achievements.
- ◆ Make suggestions and offer assistance during progress achievements.
- ◆ Give an outline to students in order to guide them in preparing an oral report or presentation. The outline may include these components:
  - ◆ Introduce your team and topic.
  - ◆ Describe your task.
  - ◆ Present results using illustrations.
  - ◆ Share problems or challenges faced during activity.
  - ◆ Make concluding remarks or persuasive comments.
- ◆ Encourage the use of note cards, posters, flip charts, slides, or multimedia equipment.
- ◆ Help students assess their own delivery skills (e.g., Am I speaking slowly? clearly? and loudly?)
- ◆ Invite guests from the community, other teachers, or parents to attend presentations to give students practice in speaking before diverse audiences.
- ◆ Register students for events as part of the Technology Student Association (TSA), or other co-curricular organizations such as:
  - ◆ Challenging Technological Issues
  - ◆ Construction Challenge
  - ◆ Prepared Speech
  - ◆ Technical Writing Challenge

### Recording Student Progress in Portfolios or Logs

Introduce students to the importance of keeping or documenting their ideas and progress while designing and completing engineering and invention activities.

1. Provide examples of design portfolios or logs from previous students, engineers, and architects. Provide or suggest the page format. Encourage them to use three-ring notebooks, folders, or computer files to keep their work organized. For an example, see Teaching Students About the Impact of Technology.
2. Encourage students to design a logo and title for their team project and use it on the cover and throughout the portfolio or log.
3. Provide lessons in illustration using felt tip pens, computer software, and CAD modeling in order for students to include representations of final designs in their portfolios or logs.
4. Pose questions or writing prompts to students and ask them to reflect on different aspects of their learning. Ask students to explain their understanding of the topic being discussed and to express concerns, thoughts, or ideas. Questions or writing prompts that may be used to help students start writing are:
  - ◆ Develop a calendar outlining work to be done.
  - ◆ Make a list of work completed during the time period.
  - ◆ Report about a person known to have contributed to technological developments.
  - ◆ Use diagrams to represent understanding of a topic.
  - ◆ How would you explain your topic to a student who didn't understand?
5. Review the portfolios or logs on a regular basis to ensure that students keep them current with steps and progress made.
6. Evaluate each portfolio in relation to the solution of the project and the actual learning achieved by students.
7. Display and share the completed portfolios with other students, teachers, parents, and the public. Have students use their theme in their oral presentations and events, such as TSA competitions and science fairs.

### **Contents for Design Portfolio or Log**

1. Title page, logo, and student's or group's name
2. Table of contents
3. A letter from the student explaining his or her learning and growth
4. Problem statements or design briefs
5. Ideas (all illustrations and sketches produced at each stage)
6. Observations from investigations and actual data collected
7. Testing or evaluation of solutions
8. Final solutions and recommendations
9. Reflections and responses to questions, concerns, thoughts, ideas

### **Format Resources**

Magazines, textbooks, and technology and engineering activity guides contain various formats for design portfolios and design logos. (See Chapter 3, Section B.)

### **Method 7-Using Simulations to Teach Technology**

#### **Overview**

Simulations enable students to relate what they are learning in class to real-life situations. This exciting method of instruction allows students to learn by doing or by acting. The students go from

observers to being actual participants. Typically, simulations or gaming takes place in groups and involves models of larger or smaller objects or games involving situations with risks and rewards.

## **Definitions**

**Simulation:** This teaching strategy engages students in roles that are similar to real life. The students will learn how to apply the concepts learned in class, such as expressing their views and making decisions, to these real-life situations.

**Gaming:** Gaming refers to the less realistic activities in which students are presented with a situation involving choices, risks, and pay-offs. Much is learned as students enjoy the challenge or the chance to play to win.

## **Benefits of Using Simulations**

Simulations add reality and excitement to learning. Students are motivated to learn and react to the problems presented, because they realize that other people will be affected. Higher motivation results in higher learning.

## **Samples of Simulations**

- ◆ “Challenger Learning Centers” engage students in a space shuttle mission in which students use problem solving, creativity and critical-thinking skills. Mathematics, science, and technology content is learned by students working in teams and communicating to achieve a common goal.
- ◆ Enterprise or mass production simulations engage students in experiencing and simulating a manufacturing plant.
- ◆ Museum exhibits provide opportunities for students to simulate a large or complex system.
- ◆ Models may be made to simulate larger or small devices.
- ◆ Computer simulations enable students to simulate activities of large-scale enterprises, such as cities, governments, and other such systems.
- ◆ Conducting meetings with representatives from the board of directors, managers, stockholders, and other groups provide students with opportunities to simulate operations that are typical in the business world.

## **Method 8-Using Concept Maps™ to Facilitate Learning**

### **Overview**

In the early 1970’s, Joseph Novak and a team of graduate students developed concept maps as a tool to engage students and as a way to encourage them to think about their learning. “As an alternative to typical testing, concept mapping is proving to be a powerful tool for evaluation, and this, together with other new evaluation methods that are beginning to emerge, show promise both for educational research and practice.” (Novak, 1998, p.17). Concept maps are visual pictures of how students think, and they make connections of their ideas and meaning out of their thoughts.

Concept mapping is a method that will enable teachers to guide students as they learn the concepts and principles of technology. Often students acquire new terminology, ideas, rules, procedures, and strategies, but do not know how they are linked together or how they may help them in their learning. Through instructions on how to develop a concept map, students are able to make those connections as well as make adjustments in their thinking as new experiences allow new information to be added.

Teachers may use concept maps to determine what students already know about a topic or concept, how previous learning is retained, and what areas need reinforcement. These maps can be used to show teachers what instruction needs to be given to address new information and help provide students with a means to make connections with their prior knowledge. The use of concept mapping helps students to answer the question “How is this going to help me?”

After students have created their concept maps, teachers should follow with activities or other instruction that will enable students to build on their knowledge, explore new ways of looking at relationships, and have meaningful discussions that will help address student confusion or enhance their understanding.

There are various means through which students may develop their concept maps, from using simple pencil drawings on paper to the more elaborate use of computer software specifically designed to construct concept maps.

### **Definitions**

**Concept map:** A map depicting the hierarchical order of key concept words and propositions. The map is designed with a key word or question at the top, and then related words, phrases, and ideas are linked with arrows and lines depicting relationships and connections. The linkages also have phrases that show the relationship.

**Concept:** A broad category of information that has distinguishing features that are commonly held.

### **Getting Started**

When students are first learning how to make concept maps, it is best to begin by giving them a key topic or word and related words, phrases, and ideas. For example, suppose students are to create a concept map with the key word transportation. Related words could be the following: vehicle, car, pathways, road, highway, street, streetlight, gasoline, tires, railroad, airplane, engine, and boat.

The concept map a student develops would then be created by ranking the words. The most general word would be placed at the top. For example, the word transportation, which is the broadest and most inclusive word listed above, would be placed at the top of the page. Next, the remaining words or ideas would be arranged underneath in descending order until all words were used.

If more than three or four words can be placed under a word, then begin to look for another word that would encompass that word. There is usually an intermediate word that would address the extra words and thus create another level.

Connect the words, ideas, phrases, and concepts with lines. Words that help you follow how the words are connected or linked should then be added. For example, transportation would have vehicle linked to it, and the connecting phrase could be requires a. This linking phrase explains how a vehicle is part of transportation. Use of labels on the lines is essential in order to provide meaning and clarity to the student's thinking process. These labels will be used by the student and teacher to clarify understanding and to discover confusion.

The map should be reworked or modified as students continue to add to their knowledge, change their thinking, or discover another connection not previously made. This could become a yearlong procedure for students and can be a valuable tool to prepare students for various types of assessments, or it could be an actual assessment device. Teachers are cautioned to not use mapping as an assessment device until students have had ample time to develop understanding and have shown confidence in their use of the concept map.

### **Sample Concept Map**

Using the words listed below, a concept map was developed. Students do not have to use all of the words, and they do not have to appear in any particular order.

### **Helping Students Develop Concept Maps**

- ◆ Students should be encouraged to develop their own concept maps to guide them in understanding what they have learned.
- ◆ Encourage students to revisit their concept maps and revise them as new knowledge is acquired.

Remind them that it is part of the learning process to change thinking and modify original ideas.

- ◆ Provide a handout that depicts the components of a concept map or have students refer to earlier samples.
- ◆ Assist students with writing and selecting appropriate words, phrases, or ideas for labels. Avoid giving them wording, but lead them to discover the links they want to make based on their own understanding and thinking.

## **Method 9-Standards-Based Student Assessment**

### **Overview**

When curriculum and instruction is based on *Standards for Technological Literacy*, students' understanding of their cognitive and procedural knowledge should be assessed by criteria derived from the content and meaning of the standards. This assessment process should be a collaborative effort, between students and teachers, so that the students will know ahead of time what will be expected of them and at what level of proficiency.

In the past, the result of activities (whether the project was successfully completed or not) was the goal of the assessment of students. How well students were able to complete a project, how effective or proficient they were at manipulating materials, or how well they would perform under pressure was the main form of assessment. In a standards-based activity, the goal is not just focused on the product of the activity. Rather, focus is equally given to the student's learning of the content that supports the development of the activity. The completion of the activity is still an important factor. However, equally, if not more important, is what the students understand about the content and how well they know how to do the necessary procedures.

The use of standards helps to focus the curriculum, helps to make expectations clear to students through consistency and cohesion, and, as a result, helps to improve the learning of students. The development of standards-based assessments should be based on existing units of study that are standards-based, include student interests, and provide for alternative means to examine student learning.

Preparing a standards-based assessment includes providing students with multiple means to display their work. Examples of student work may take various forms, but underlying them should be a clear picture of the standards that are being addressed and the methods that are used to address them. For example, assessment of a student is not limited to the end of the activity. You may want to embed assessment in the instruction to help guide decisions for future direction.

As a result, assessment is often taken informally to provide information on how well the student is moving toward attaining a standard. Taken as a whole, the assessment examples provide evidence of what students know and are able to do. Several sources of evidence are required to demonstrate that a student understands or has attained a standard. Therefore, multiple opportunities to explore a standard are necessary and helpful to students.

### **Definitions**

Alternative Assessments: This type of assessment, synonymous with authentic- and performance-based assessment, requires students to actively accomplish significant tasks using the knowledge and skills learned. Examples of types of assessment are demonstrations, projects, written or oral reports, student interviews, portfolios, and self-assessments that are graded or evaluated.

Standards-Based Assessment: Student products and performances are assessed by using measurable objectives that relate to the overall desired content to be learned as identified in the standards.

Scoring Guide: Scoring: Guides are a means to score the work of students that show detailed criteria for each level of accomplishment. It should be developed with student input so that they may develop an understanding of value-added learning. A rubric enables the teacher and student to know what is to be addressed and how it will be weighted.

## **Benefits of Standards-Based Assessment**

- ◆ Provides specific targets and expectations for students to achieve.
- ◆ Allows students to learn how to evaluate their own projects and to be aware of their progress.
- ◆ Generates more information regarding how a student is progressing toward understanding the content than most traditional forms of assessment. These results can then be used to measure and show the student's progress and accomplishments.
- ◆ Uses a variety of means to communicate, such as multimedia, models, and simulations, in place of traditional question-and-answer form of a test.
- ◆ Encourages accountability of students and provides a means to demonstrate learning to parents, administrators, and the community.

## **Getting Started**

1. Determine your goals for the activity and select the specific standard statements for which the activity will address. (Note: Near the end of each activity in Chapter 2, a list of criteria is presented to provide you with a guide to begin developing assessments.)
2. Determine what your students already understand and can do.
3. Based on the information in the first two steps, determine what is expected of students in meeting the standards addressed and how it will be incorporated into the assessment. In addition, determine how the completion of the activity will be used in the assessment process. (See scale, levels 1-4, in sample rubric as a guide.)
4. Write descriptors of the expectations that describe level of attainment from low to high accomplishment. These statements should be clearly stated and should be based upon facts and not the judgments of the teacher. Involve students in writing these descriptors in order that they may develop ownership of their learning.
5. Design the presentation of the activity and related curriculum activities that reflect the use of Standards for Technological Literacy and involves a variety of assessment techniques and methods.
6. Identify the alternative assessments that may be used, such as demonstrations, projects, written or oral reports, student interviews, portfolios, and self-assessment.
7. Prepare a rubric or scoring guide, checklist, or holistic statement for use in assessing the student's work. When developing a rubric or scoring guide, consider all aspects of the standards and allow for student innovation and creativity as they continue to learn the content. (See an Example of a Rubric.)
8. Collect examples of student work in order to maintain a record of achievement and to ensure consistency and visual clarity.

### Assessing Learning in Problem-Solving

In a study conducted by Roger Hill, several mental processes were observed in order to record which were used by students involved in the study of technology. The following mental processes are indicators that students are learning to be problem solvers. These items can be used, along with traditional test and project grading, in order to assess student achievement.

Defining the Problem or Opportunity	Interpreting Data
Observing	Constructing Models and Prototypes
Analyzing	Experimenting
Visualizing	Testing
Computing	Designing
Communicating	Modeling
Measuring	Creating
Predicting	Managing
Questioning and Hypothesizing	

(Hill, R., 1997, p. 31-46).

For more information on assessment and problem solving, see Hill (1997). For more information about the relationship between assessment and standards, see Standards for Technological Literacy (ITEA, 2000).

## An Example of a Scoring Guide

Scoring Guides are based on the identified criteria taken from the content standards. Points or words are assigned to each phrase or level of accomplishment. This method gives feedback to the students about their work in key categories, and it can be used to communicate student’s performance to parents and administrators. The scoring guide example is designed to assess what and how well students understand the standards addressed in an activity.

Scale Criteria From Standards	1 Beginning to Attain Standard	2 Nearly Attained Standard	3 Achieved Standard	4 Exceeded Standard
Design Brief Design Process	Suggested one idea and decided it was good. Did not interact with group.	Had two or three ideas but did not share or interact with the group.	Participated fully with the group and provided suggestions and varied ideas.	Participated fully with the group and helped others come to understand the process.
Identified Criteria and Constraints	Did not understand what was needed.	Provided a few constraints, but was confused when using the terminology.	Understood the terminology. Was able to contribute suggestions to the group.	Understood the terminology. Considered conditions outside of school and related them.
Design Fits Need	Ignored Criteria.	Used criteria haphazardly.	Incorporated all criteria.	Used all criteria, and modified the product to fit them.
Design Completed Using Constraints	Developed design without considering constraints.	Used most constraints, but was not sure why.	Appropriately used constraints and completed design.	Completed design using constraints efficiently and effectively.
Researched Space Life	Made up information.	Read textbooks, but wasn’t sure of the information.	Researched using available resources. Compiled findings accurately.	Researched using resources and presented a formal presentation.
Used Model	Model was not made from sketch and did not use criteria or constraints.	Model incomplete. Used sketches.	Model resembles design and meets the design brief challenge.	Model clearly shows solution to problem, and extra care was taken to incorporate all aspects of the design brief.
Tested and Modified Model	Did not test model.	Model was tested. No follow-up action was taken.	Model was modified after testing.	Model was modified and tested until results were found. Presentation details the testing and modification.

### Method 10-Engaging Community and Corporate Partnerships

#### Overview

Numerous local corporations are involved in tasks and enterprises that are related to the content being taught in technology and engineering classes. Many of these corporations are interested in helping schools and young people through giving financial support, materials, time, and tools and sharing information. Teachers who seek these community and corporate partnerships enhance their classroom environment and broaden the educational experiences of their students.

#### Definitions

## **Community Partnerships**

Community partnerships are often established by a middle school to encourage interaction between the students and teachers and the community as a whole. Through partnerships, schools are able to demonstrate how business and industry contribute to the community. Students learn about cooperation, are encouraged to participate in community activities and events, and discover the many resources available to them, such as libraries, museums, government agencies, and civic organizations.

Corporate Partnerships: A school or technology and engineering department forms a partnership with a business or industry in the community in order to enhance the study of particular technologies or processes.

### **Resources a School May Give**

Establishing a dialogue with a business or corporation helps in identifying the needs and interests of both parties and how the school may help in offering some type of help. For example, if a company wants to try out their new instruction manual, students could read and comment on its user-friendliness. Teachers may be able to train employees in human relations or problem-solving skills or teamwork. Keeping an open discussion between the school and corporate partners will help in determining ideas for a “give and take” relationship.

### **Resources a School May Receive**

Frequently schools are able to request financial assistance from community and corporate partnerships. However, active partnerships can result in greater mutual benefits, such as guest speakers, volunteers, field trips, and donated supplies and equipment. Engineers, who volunteer their time in schools, are an effective addition to teaching technology. When time permits, personnel from corporations enjoy contributing their knowledge through presentations, demonstrations, simulations, or assisting teachers with developing curriculum and lesson plans.

## **Method 11-Using Modular Instruction**

### **Overview**

A clean, safe, and attractive laboratory-classroom is important to the learning process for students. However, the laboratory-classroom is secondary to the curriculum or content goals of the program of study. In other words, the curriculum should be the delivery method of the content and not the accomplishable in the laboratory-classroom provided. Most teachers are able to adapt existing facilities to the needs of students, while others are involved in the design, selection, and development of new instructional systems.

As the technological literacy standards are implemented, teachers will want to adapt their lessons and facilities in order to properly implement the ideas and vision. Modular systems are an effective method to use and help in school renewal. As with any method, teachers will be able to enhance the use of the modular systems through incorporating their experience in the development of dynamic and evolving units of study.

There are many benefits to modular instruction, such as:

- ◆ using a combination of multimedia instructional technologies (television/video, computers, textbooks, Internet);
- ◆ teaching a number of important concepts in a short period of time;
- ◆ introducing several career choices in the working world;
- ◆ encouraging cooperative learning, self-discipline with independent (self directed) learning; and illustrating applications of mathematics, science, social studies, and language arts through various activities.

Modular instruction is what we make of it. Each teacher needs to consider a basic module as just that, a basic. In order to be standards-based, a module will need to be adapted and modified to meet the

needs of all students in the laboratory-classroom. Open-ended, problem-solving opportunities should be included. Modules that are written with a prescribed lesson should be investigated and adjusted to meet the needs of all students and the local guidelines and curriculum.

## **Definitions**

Modeling Lab: This type of learning environment contains table top machines and a variety of tools and materials to promote the exploration, investigation and creation of a variety of products and systems. The modeling lab provides for individual or group learning activities. Support materials may be used, such as computers, multi-media, and textbooks.

Modular Lab: This type of learning environment uses modules to create learning centers throughout the technology and engineering room. The module contains instructional equipment that delivers the content or lesson, generally to show students. The students learn and work through the use of a booklet or a computer. Support material is provided through watching video, reading textbooks, and building a project using appropriate tools, machines, and materials as identified in each module.

Combination Modeling and Modular Lab: This type of learning environment combines the modeling and modular labs into one laboratory-classroom. Students work in a variety of settings from prescribed modules in pairs to group projects developed by the student using a combination of modules and equipment. Students are able to move from identified learning goals to free exploration and development of products and systems. Opportunities for learning about inventions and innovations provide open-ended problem-solving experiences.

## **Getting Started Using Modular Instruction**

Due the variety of modular packages available, the recommendations are written to give teachers a starting point in helping them make modules standards-based. Teachers are advised to consider the needs of their students, the local curriculum, and the type of module system and facilities available in making adjustments to modules. In addition, it is recommended that teachers consider making small changes. Some modular packages that come with a CD-ROM version of the curriculum allow teachers to edit and make adjustments. Teachers should use the instruction provided in the modules as a beginning and gradually add suggested methods to enhance each module. The following suggestions are to be used as a guide and not intended to be the only correct means to implement Standards for Technological Literacy.

## **Modifying a Module**

1. Read and become familiar with *Standards for Technological Literacy* and the methods suggested in this guide.
2. Read through the notebook or lab manual provided for each student or pair of students. Make notes on specific pedagogy or practices that are missing from the module. For example, if students are expected to read about bridges in a modular library before they may begin their design activity, add the component of an Internet or CD-ROM search to the library search. Provide specific questions students should be addressing when doing their research, such as:
  - ◆ When was the bridge first developed?
  - ◆ Why was the bridge developed?
  - ◆ Who does it help? Where is it used?
  - ◆ Was a particular skill or ability needed to help in the development of the bridge?
  - ◆ What important design ideas were necessary to help the bridge stand and function properly?
  - ◆ What particular geometric shapes are most often used in bridge design? Why do you think this is so?

Choose a particular bridge to research to answer these questions:

- ◆ If this bridge has a name, what is it?
  - ◆ Where is it located? When was it erected?
  - ◆ Who designed/engineered this bridge?
  - ◆ What was happening in history when this bridge was developed?
  - ◆ How has the bridge changed over time?
  - ◆ What benefits or changes came as result of this new bridge?
3. Decide what methods you may add to your module that will enhance and help you implement Standards for Technological Literacy. The focus is on helping students think about their learning and to develop ownership in their knowledge of technology through their active learning. For example:
- ◆ Method 1: Using Design Briefs to Challenge Problem Solvers may be added to the specifications page provided in the module. Teachers may use the Template for Design Brief on page 12 or design their own design brief layout.
  - ◆ Method 2: Teaching Students to Assess the Impact of Technology may be added at the end of a module activity as part of the completion of the module or as an extension. Students are given an opportunity to reflect on their knowledge of technology and its relation to their own world.
  - ◆ Method 6: Sharing, Reporting, and Recording Information is easily added to the documentation that students are required to do in many modular packages. Using the reporting as a means of assessment at the end of a module will allow students to demonstrate their knowledge and meet strict deadlines.
  - ◆ Method 8: Using Concept Maps to Facilitate Learning may be used as a pre- and post-test assessment as well as used throughout the module to reinforce student development of vocabulary and vocabulary relationships with the processes the students are learning.
  - ◆ Method 9: Standards-Based Student Assessment allows students to be a part of their own learning in determining what is important for them to know. Many modules already have questions or sections allocated for assessment. Providing opportunities for students to develop rubrics or determine what is acceptable helps them identify their level of success and empowers them to develop strong problem-solving and critical thinking techniques.
4. Gradually implement your changes making notes about what worked smoothly, what still needs to be modified, and what other adjustments you may still be able to make. Consider all possibilities and continually refer to Standards for Technological Literacy and this guide. Most importantly, remember that change takes time and making adjustments to modules should be done with care.

### **Using Modules to Their Fullest Potential**

Modular instruction has the potential for every pair of students to be learning different content, doing different activities, and solving different problems with little interaction with other students. The following suggestions allow students to expand their learning opportunities and to experience different dimensions of their learning while sharing their ideas and thoughts:

1. Let students talk to the class about their particular solution to project. Provide a display area where students may place their creative thinking.
2. Develop a culminating activity that will utilize the learning of two, three, or more modules so that students combine their efforts into a group project.
3. After students have completed several modules allow them to select one for more intensive study. Include several methods mentioned in this guide that provide guidance and directed learning.





## **Chapter 5 – High School Technology and Engineering**

## Chapter 5 High School Technology and Engineering

### 1 – Introduction

This chapter contains the materials from the **ITEA-STEM Center for Teaching and Learning™**, Foundations of Technology Education Curriculum (ITEA 2001). This document was developed by and for the **STEM Center for Teaching and Learning™** consortium for use by its members. Missouri has been a Consortium member since 2001, giving Missouri the rights to utilize, copy, and distribute this product to Missouri teachers.

### 2 – Course Selection, Descriptions, and Rationales

There are two program options available to schools and both are copyrighted and require a contractual agreement between the local educational authority and the program entities listed with each respectively and both are eligible for Career Education Program Approval.

#### Option # 1 – Engineering byDesign™

##### Mission

We live in a technological world. Living in the twenty-first century requires much more from every individual than a basic ability to read, write, and perform simple mathematics. Technology affects every aspect of our lives, from enabling citizens to perform routine tasks to requiring that they be able to make responsible, informed decisions that affect individuals, our society, and the environment.

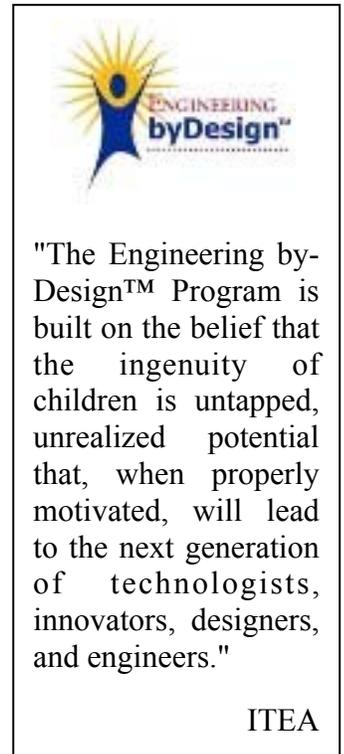
Citizens of today must have a basic understanding of how technology affects their world and how they exist both within and around technology. Technological literacy is fundamentally important to all students. Technological processes have become so complex that the community and schools collaborate to provide a quality technology program that prepares students for a changing technological world that is progressively more dependent on an informed, technologically literate citizenry.

##### Vision

The ITEA model technology program is committed to providing technological study in facilities that are safe and facilitate creativity, enabling all students to meet local, state, and national technological literacy standards. Students are prepared to engage in additional technological study in the high school years and beyond. Students will be prepared with knowledge and abilities to help them become informed, successful citizens who are able to make sense of the world in which they live. The technology program also enables students to take advantage of the technological resources in their own community.

##### Goals

- ◆ Provide a standards-based K-12 program that ensures that all students are technologically literate.
- ◆ Provide opportunities for all students without regard to gender or ethnic origin.
- ◆ Provide clear standards and expectations for increasing student achievement in math, science, and technology.
- ◆ Provide leadership and support that will produce continuous improvement and innovation in the program.
- ◆ Restore America's status as the leader in innovation. Provide a program that constructs learning



from a very early age and culminates in a capstone experience that leads students to become the next generation of technologists, innovators, designers, and engineers.

## Organizing Principles

The EbD™ program is organized around seven principles. These principles are very large concepts that identify major content organizers for the program. In order of importance, the seven organizing principles are:

- ◆ Engineering through design improves life.
- ◆ Technology has and continues to affect everyday life.
- ◆ Technology drives invention and innovation and is a thinking and doing process.
- ◆ Technologies are combined to make technological systems.
- ◆ Technology creates issues that change the way people live and interact.
- ◆ Technology impacts society and must be assessed to determine if it is good or bad.
- ◆ Technology is the basis for improving on the past and creating the future.

The curriculum for this option is provided by **ITEA- STEM Center for Teaching and Learning™**; and should be coordinated through the Missouri EbD™ State Leader. EbD™ is a copyright protected program that can only be used by contractual agreement between the local educational authority and **ITEA-STEM CTL**. The Technology and Engineering program is eligible for Career Education program approval. Course description, code and sequence follows the EbD™ format:

Foundations of Technology – CD (100426) FOT Prepares students to understand and apply technological concepts and processes that are the cornerstone for the high school technology program. Group and individual activities engage student in creating ideas, developing innovations, and engineering practical solutions..

Technological Issues and Impacts – CD (100427) TII The student of technological issues and impacts allows students to develop skills in asking critical questions as well as understanding alternative viewpoints and their origins, and gives students the confidence to be involved in deciding which technologies to develop, which to use, and how to use them.

Technological Design – CD (100428) TD Engineering scope, content, and professional practices are presented through practical applications. Student in engineering teams apply technology, science, and mathematics concepts and skills to solve engineering design problems and innovate design. Students research, develop, test, and analyze engineering designs using criteria as design effectiveness, public safety, human factors, and ethics.

Engineering Design – CD (100431) ED Offers students the opportunity to understand and apply knowledge and skills required to create and transform ideas and concepts into a product that satisfies specific customer requirements. Students will experience design engineering in the creation, synthesis, iteration, and presentation of design solutions and will coordinate and interact in authentic ways to produce the form, fit, and functions documentation, with appropriate models to completely define a product. Highly rigorous.

Advanced Design Applications – CD (100429) ADA The goal is to provide an engineering or technical base for high school students who plan to continue their education in technical or engineering programs at the community college or university level.

Advanced Technological Applications – CD (100430) ATA The goal is to provide an engineering or technical base for high school students who plan to continue their education in technical or engineering programs at the community college or university level.

## Option # 2 – Project Lead The Way© -- Engineering

### Mission

Project Lead The Way© (PLTW©) mission is to ensure that America succeeds in the increasingly high-tech and high-skill global economy, by partnering with middle schools and high schools to prepare students to become the most innovative and productive in the world.

### Overview

PLTW© is the nation’s leading provider of rigorous and innovative Science, Technology, Engineering and Math (STEM) education for middle schools and high schools. PLTW’s comprehensive curriculum, which is collaboratively developed by PLTW teachers, University educators, engineering and biomedical professionals, and school administrators, emphasizes critical thinking, creativity, innovation and real-world problem solving. The hands-on, project-based program engages students on multiple levels, exposes them to areas of study that they typically do not pursue, and provides them with a foundation and proven path to college and career success in STEM related fields.

The curriculum for this option is provided by Project Lead the Way© (PLTW©) and should be coordinated through the Missouri PLTW© State Leader. PLTW© is a copyright protected program that can only be used by contractual agreement between the local educational authority and PLTW©. The Engineering program is eligible for Career Education program approval. Course description, code and sequence follows the PLTW© format: Principles of Engineering, Introduction to Engineering Design, Computer Integrated Manufacturing, Digital Electronics, and a capstone course, Engineering Design and Development.

### Foundation Courses

Introduction to Engineering Design© – CD (100405) IED This is a course that teaches problem-solving skills using a design development process. Models of product solutions are created, analyzed and communicated using solid modeling computer design software.

Principles of Engineering© – CD (100404) POE This is a course that helps students understand the field of engineering/engineering technology. Exploring various technology systems and manufacturing processes help students learn how engineers and technicians use math, science and technology in an engineering problem solving process to benefit people. The course also includes concerns about social and political consequences of technological change.

Digital Electronics© CD (100406) DE This is a course in applied logic that encompasses the application of electronic circuits and devices. Computer simulation software is used to design and test digital circuitry prior to the actual construction of circuits and devices.

### Capstone Course

Engineering Design and Development© – CD (100422) EDD An engineering research course in which students work in teams to research, design and construct a solution to an open-ended engineering problem. Students apply principles developed in the four preceding courses and are guided by a community mentor. They must present progress reports, submit a final written report and defend their solutions to a panel of outside reviewers at the end of the school year.

### Specialty Courses (4) (Optional)

Computer Integrated Manufacturing© – CD (100407) CIM This is a course that applies principles of robotics and automation. The course builds on computer solid modeling skills developed in Introduction to Engineering Design, and Design and Drawing for Production. Students use CNC equipment to produce actual models of their three-dimensional designs. Fundamental concepts of robotics used in automated manufacturing, and design analysis are included.

Civil Engineering and Architecture© – CD (100408) CEA Teams of students collaborate on the development of community-based building projects and conceptual design for project presentations.

Aerospace Engineering© – CD (100409) AE Students learn about aerodynamics, astronautics, space-life sciences, and systems engineering through hands-on engineering problems and projects.

Biotechnology Engineering© – CD (100410) BE Students apply biological and engineering concepts related to biomechanics, genetic engineering, and forensics.



## Chapter 6 – Technology Student Association™ (TSA™)



MISSOURI DEPARTMENT OF ELEMENTARY AND SECONDARY EDUCATION  
DIVISION OF CAREER EDUCATION

**Chapter 6**  
**Technology Student Association**  
**"Learning to live in a technical world"**

**1 – Introduction**

The Technology Student Association (TSA) is the only student organization devoted exclusively to the needs of students interested in technology and engineering. Open to students enrolled in or who have completed technology and engineering courses, TSA's membership includes over 150,000 middle and high school students in 2,000 schools spanning 48 states.

TSA is supported by educators, parents and business leaders who believe in the need for a technologically literate society. Members learn through exciting competitive events, leadership opportunities and much more. The diversity of activities makes TSA a positive experience for every student. From engineers to business managers, our alumni credit TSA with a positive influence on their lives.

**2 – Mission**

The Technology Student Association fosters personal growth, leadership, and opportunities in technology, innovation, design, and engineering. Members apply and integrate science, technology, engineering and mathematics concepts through co-curricular activities, competitive events and related programs.

**3 – Local Chapters**

TSA chapters take the study of STEM (science, technology, engineering, mathematics) beyond the classroom and give students the chance to pursue academic challenges among friends with similar goals and interests. Together, chapter members work on competitive events, attend conferences on the state and national levels and have a good time raising funds to get there. Chapter organization develops leadership, as members may become officers within their state and then run nationally. Our chapters are committed to a national service project and are among the most service-oriented groups in the community.

**4 – Why Join TSA?**

Perhaps the most important benefit of TSA membership is the inspiration and enthusiasm that students gain from receiving recognition for applying their knowledge. Demonstrating skills in a forum beyond school walls motivates students, especially when there is a large, like-minded audience of peers who support them. Other reasons include:

- ◆ enhance technological literacy and leadership skills
- ◆ work on complex activities from start to finish
- ◆ compete on local, state and national levels
- ◆ develop leadership skills
- ◆ meet and work with business and industry leaders
- ◆ attend organized meetings
- ◆ network with students and teachers with similar interests from all over the United States
- ◆ contribute time and effort to a national service project
- ◆ receive national membership services, including the online TSA newsletter, School Scene,
- ◆ receive recognition through TSA's honor society, scholarships and achievement programs
- ◆ have a voice in a national organization that is helping to shape the future of technology and engineering

**5 – How to Join TSA**

The directions below will guide you through the affiliation process. This year each registered chap-

ter advisor will receive a complimentary High School or Middle School tri-fold, shipped once we have received a purchase order or payment. Hard copies of invoices will not be mailed unless your purchase order specifies a separate billing address. The e-mail confirmation you receive is your invoice. Please give a copy to your accounts payable department.

1. Click on the Chapter Affiliation button.
2. For returning advisors, input username and password to login. New schools and advisors without logins please select “Click Here” to request a login.
3. Input or review your school and membership information.
4. Required fields that must be updated are:
5. Principal
6. Membership Type CAP or Individual
7. Number of Members
8. Hit submit once all information has been entered.

On the Membership Roster page: Note: Once you submit a students name they are a member of TSA and another students name cannot be substituted during the membership year. Spelling corrections may be sent mail to [shonour@tsaweb.org](mailto:shonour@tsaweb.org).

CAP membership: click on “Input Roster” and you will have the option to download and import a roster template or you may type in student names directly into the system.

Individual membership: click on Input Roster and type in the student names. Hit Save after each student is entered.

All advisors registered during the 08/09 affiliation are automatically included on your registration for this year. Please use the “Add/modify Advisor” button to change your advisors selections for 09/10 affiliation.

Once you have made all your affiliation selections, click on “View Invoice and Payment Screen.”

After reviewing your invoice, if you need to make changes click on the Return to Chapter Information button.

Once you have verified that your invoice is correct, select payment by purchase order or credit card. Once you hit submit your existing chapter information cannot be changed. Please fax your purchase order within three business days.

A confirmation/invoice will be emailed to the address you have already provided. Please submit this emailed invoice to your financial department for payment.

(Visit this web site to register at: <http://www.registermychapter.com/tsa/nat/>)

## **6 – About TSA**

### **Purpose**

The Technology Student Association provides opportunities for leadership development and training through involvement in a variety of activities. TSA promotes technology and engineering as an integral part of the total education system. Knowledge is increased and broadened as members are informed of developments in technology. Student respect is inspired for the dignity of technology in our society. TSA encourages scholastic motivation by providing opportunities to integrate and use the knowledge and skill of other education disciplines.

Chapter activities are considered an essential and integral part of the students' development. TSA

believes that every student should enter a dynamic world as leaders who are technologically literate and possess the ability to solve problems.

### **How TSA Develops Leaders**

TSA uses several methods to help students with personal development. They are the leadership connections program, competitive events, achievement program, and a service projects. Everyone is encouraged to participate.

#### **Leadership Connections Program**

Such vital areas as public speaking, chapter team competition, group dynamics and cooperation with others are all essential parts of the TSA program. In addition, the TSA member has the opportunity to take part in local, district, state and national leadership conferences which offer the opportunity to improve on personal excellence. TSA believes students should provide leadership in activities which affect their school, community, work, and nation.

#### **Competitive Events**

TSA members compete in a variety of technology categories ranging from Aerospace Technology to Technical Research and Report Writing. There are two levels of competition for grades 6-12. Level I is for 6th through 9th grade and level II is for 9th through 12th grade. During the awards ceremonies the top ten finalist in each event are recognized on the platform and TSA awards the winners in each event with a first, second, and third place recognition.

#### **Technology Achievement Program**

The Achievement Program is a self-initiated program designed to motivate students in their technology and engineering programs and to be recognized for their efforts in leadership development, school/community service, understanding of technology, and career/personal planning. It is composed of three levels: bronze, silver, and gold. The first level of bronze is achieved at the local level, the second level of silver is achieved at the state level, and the third level of gold is achieved at the national level. Points are accumulated through a variety of projects and activities.

#### **Service Projects**

TSA promotes service to the community by carefully selecting a national organization as its service partner. TSA's partner is now the American Cancer Society. Find out how your chapter can become involved by clicking on: [American Society](#).

TSA chapter activities are an integral part of the school technology and engineering program and provide added dimension to school/community activities. TSA activities enhance the instructor's means of creating technology related challenges that benefit the student. TSA increases the opportunity for individual growth and participation in an environment.

### **7 – Goals of Technology and Engineering**

Because technology is an integral part of the American Culture, it is necessary for schools to provide students with an appreciation and understanding of the role and dynamics of technology in our society. Technology springs from the human abilities to reason, solve problems, create, construct, and use materials imaginatively. The study of technology, integrated into the school curricula, promotes the development of these abilities and prepares students for a fulfilled and responsible adulthood. Technology and engineering goals at the elementary, middle school, and high school levels focus on students acquiring specific abilities and perspectives.

Through the use of tools, materials, and the design and technology process, student learning at the elementary level will be enhanced and contribute to overall personal development and technological awareness.

Students at the middle school level will gain a greater understanding of technology's role in contemporary society, including future career opportunities and related programs of study.

Technological skills and knowledge attained by students at the high school level will yield occupational readiness, consumer awareness, and personal enrichment.

## **8 – The Benefits to Having a TSA Chapter**

### **TSA Benefits the School**

TSA chapter activities are an integral part of the school technology and engineering program and provide added dimension to school/community activities. TSA activities enhance the instructor's means of creating technology related challenges that benefit the student.

TSA increases the opportunity for individual student growth and participation in an educational environment. Some benefits to the school are that TSA:

- ◆ promotes, expands, and improves the total technology and engineering program
- ◆ creates additional means of developing student interest in broad-based learning
- ◆ promotes the school, with visibility provided through school and community projects
- ◆ provides opportunities for students to integrate learning experiences from other instructional areas
- ◆ integrates Career & Technical Student Organization (CTSO) leadership development for meeting fourth cycle MSIP expectations. DESE, Common Standards for Career Education Programs, Standard five (5) [http://dese.mo.gov/divcareered/common\\_program\\_standards.htm](http://dese.mo.gov/divcareered/common_program_standards.htm).

### **TSA Benefits the Student**

TSA students have common objectives and interests. Each is learning about his or her role in our technological society.

TSA activities can have a tremendous effect upon the attitudes, growth, and development of each member. An important comparison to make with the *Accreditation Board for Engineering and Technology* ©, ABET Engineering and Technology Standards© reveals many key points that TSA student members are expected to know and be able to do in their study of technology. The ABET© standards require that engineering programs must demonstrate that their graduates have:

- ◆ an ability to apply knowledge of mathematics, science, and engineering
- ◆ an ability to design and conduct experiments, as well as to analyze and interpret data
- ◆ an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- ◆ an ability to function on multidisciplinary teams
- ◆ an ability to identify, formulate, and solve engineering problems
- ◆ an understanding of professional and ethical responsibility
- ◆ an ability to communicate effectively
- ◆ the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- ◆ a recognition of the need for, and an ability to engage in life-long learning
- ◆ a knowledge of contemporary issues
- ◆ an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

To learn more about ABET© Standards go to <http://www.abet.org/>.

For more information about TSA and starting your own school chapter, log onto the Missouri TSA web site: [www.motsaweb.org](http://www.motsaweb.org) or the National TSA web site: [www.tsaweb.org](http://www.tsaweb.org)

## 9 – Official Charter Information

The charter application process is an exciting moment which benchmarks the first steps of achievement in your chapter's historical pilgrimage toward excellence in Leadership. Please read these guidelines carefully to ensure that your chapter application is processed correctly and in a timely manner.

The charter application process is an exciting moment which benchmarks the first steps of achievement in your chapter's historical pilgrimage toward excellence in Leadership. Please read these guidelines carefully to ensure that your chapter application is processed correctly and in a timely manner. You can access the charter application at: [http://dese.mo.gov/divcareered/tsa\\_official\\_charter\\_info.htm](http://dese.mo.gov/divcareered/tsa_official_charter_info.htm)

The following steps are in accordance with the [Missouri TSA Bylaws, Articles of Incorporation](#), Article III, Sections 1-11. These steps are designed to guide you through the application process and requirements:

- ◆ Adopt local chapter bylaws. (Use Chapter Bylaws Fill-in Form.)
- ◆ Prepare a list of local chapter members for the current year who support the application for an official charter.
- ◆ Prepare a list of your local chapter officers for the current year.
- ◆ Send a copy of your local chapter approved rooster to the State Advisor ONLY along with a copy of your completed official application form.
- ◆ [Sample Chapter Bylaws Fill-in Form](#) (Microsoft Word)
- ◆ [Official Charter Application](#) (PDF)

NOTE: (The completed purchase order should be sent to Missouri TSA,

## 10 – Steps to Starting a TSA Chapter

There are ten steps to starting a TSA chapter. The following is a brief list of these steps.

### 1. The organizing committee

This organizing committee is the first step in putting chapter control in the hands of the students

### 2. The recruitment meeting

To introduce TSA to the other students conducts a recruitment meeting. Use school announcements, bulletin boards, fliers and word-of-mouth to promote the meeting.

### 3. The membership drive

After planning you will begin your membership drive. Appoint a representative from each classroom to collect dues until officers are elected and you have a treasurer.

### 4. Officer elections

Hold elections for chapter officers. Keep the election simple. For instance, you could hold a meeting and request nominations for candidates then have a show of hands to elect officers.

### 5. The officers' first order of business

Hold a meeting of the newly elected officers. The first item of business should be petitioning the state for a charter. First, make sure your school does not already have a charter. If it has, then you don't need another. Find out by calling your state advisor. If you do need a charter you can find a charter application to complete at: [http://dese.mo.gov/divcareered/tsa\\_official\\_charter\\_info.htm](http://dese.mo.gov/divcareered/tsa_official_charter_info.htm).

Send the original and a copy of the application along with a copy of your bylaws to your state advisor.

## **6. Chapter committees**

The chapter president establishes their chapter committees.

## **7. Develop a Calendar of Activities**

The chapter's Plan of Action and the chapter's project goals, is a plan for the year. Establish a Plan of Action Committee to come up with the plan and make recommendations to each standing committee. To help chapters develop a Plan of Action you can find a sample on the [Total TSA Chapter Essentials CD](#) available from National TSA.

## **8. Vote on the Calendar of Activities**

Once the tentative Plan of Action is selected, present it to all members for their approval. The program directly influences the TSA year.

## **9. Get the necessary materials**

A well organized TSA chapter uses all of its available resources such as:

- ◆ Chapter officers attending the annual fall Missouri TSA Connections Conference.
- ◆ Becoming familiar with TSA through the use of the TSA web site and the Total TSA Chapter Essentials CD provided to chapters upon completion of the membership affiliation.

## **10. The advisor's continuing role**

TSA's philosophy is that students manage their chapter, so your role is to provide encouragement and enthusiasm to your chapter members and officers.

## **11 – Curriculum Event Information**

Follow the link below to look at: (available on CD version only)

- ◆ [High School Program Event Information](#)
- ◆ [Middle School Program Event Information](#)
- ◆ [Competitive Event Themes](#)

## **12 – TSA's History**

To view the historical information of TSA go to: <http://www.tsaweb.org/History>



## **Chapter 7 – Teaching Technology and Engineering**

## Chapter 7 Teaching Technology and Engineering

### 1. — Introduction

As most educators know, the principal facilitator of student learning is the classroom teacher. If they are successful in establishing an atmosphere of mutual respect and if they genuinely care for their students' welfare, much learning will take place. Part of this atmosphere comes from how classes are taught; some from the materials and methods used some from the accommodation of individual differences, and some from the provision of quotable instruction for all.

### 2 — Planning Instruction

Planning instruction for a Technology and Engineering program should be no different from the processes used for any other classroom/ laboratory course. Theory and common sense indicate that a variety of methods must be used in order to provide the widest range of learning opportunities for students with diverse learning styles. By thoroughly planning for educational experiences, consideration can be given to students who are visual learners, auditory learners and those who prefer learning through kinesthetic (hands-on) activity.

#### Principles of Learning

The planning of instruction must reflect careful consideration of the principles of learning. Although many have outlined these principles, one of the most understandable sets was delineated by Dr. Blair of the University of Illinois. Figure 7-1 presents these principles and it should prove to be of considerable assistance to TE instructors as they plan their instruction.

#### **Figure 7-1 Blair's Principles of Learning<sup>1</sup>**

- ◆ Without motivation there can be no learning at all.
- ◆ Without a sufficient stage of readiness, learning is inefficient and may even be harmful.
- ◆ We learn to do by doing.
- ◆ We learn to do what we do (and not something else).
- ◆ For effective learning, responses must be immediately reinforced.
- ◆ Meaningful responses are better learned and retained longer than less meaningful ones.
- ◆ For the greatest amount of transfer learning, responses should be learned in the way they are going to be used.
- ◆ An individual's responses will vary according to how he/she perceives the stimulus (situation).
- ◆ An individual's responses will vary according to the classroom atmosphere.
- ◆ Every person always does the only thing he/she can possibly do considering their physical inheritance, background of learning and the forces that are acting upon them.

#### Tischler's Thoughts on Learning

A delightful source on useful teacher hints that can effectively guide the instructor as he/she plans their teaching methods is found in Tischler's pamphlet entitled Thoughts on Learning. He has assembled a set of valuable insights but then he has moved beyond mere summary by highlighting their implications for teachers. Figure 7-2 presents a sample selection of these.

## Figure 7-2

Adapted from Dr. Glen Blair, University of Illinois-Urbana.

### *Tischler's Thoughts on Learning*

**Principle:** The whole does not necessarily equal the sum of the parts. Example: you can teach a student all about nails, screws, lumber, windows, doors and paints and he/she still cannot build a house (a system).

#### Application:

Any subject to be taught is like fitting together the pieces of a puzzle. Organize your materials so that the student first sees only the system without the details. Details often require specific skill development or prerequisites neither of which the beginner may have. Later relate each detail to its place in the system.

**Principle:** The teacher is like a person standing on a cliff watching a canoeist navigate a turbulent twisting river. From the teacher's vantage point, he/she sees the whole (the overall concept) of the problem. The student, like the canoeist experiences one surprise after another. Each turn is a new challenge. Each moment is loaded with anxiety and surprise. Oh, for the student to have the vantage point of the teacher.

#### Application:

Before starting a curriculum, a course, or a lesson, develop the concept theme. Arrange your activities so that the student is standing on the hill looking at the overall subject matter before starting into the details. Then, from the student's vantage point he/she should be better able to determine his/her future plan of action or reaction.

**Principle:** When one approaches learning as an opportunity to "discover something" rather than the task to "learn about something," the feeling of self-reward takes over, thus causing interest and in-depth investigation.

#### Application:

The teacher should organize his/her subject to excite the student toward the thrill of discovering some new thought or idea. The student will thus be motivated to learn. Discovery through learning causes a behavioral change. Repeating of fact may be dull and not contribute to learning. Discovery may lead to disappointments, but it also may lead to the thrill of greater discoveries.

**Principle:** Tell the student what and how you are going to teach him/her. Teach the student what you told him/her you were going to teach him/her. Tell the student what you taught him/her.

#### Application:

Before teaching subject matter, explain how you have organized your program and what methods of teaching you will be using. You cannot expect the student to learn, when he/she doesn't know how you expect to teach him/her. Then be sure to follow the methods you have outlined, and summarize by telling what you have taught.

2Tischler's, Thoughts on Learning, n.d.

**Principle:** Learning is easier and more effective when the student uses two or more of his/her sensory transducers.

#### Application:

For any subject, present your material so that you require the student to use as many of his/her senses as possible. Hearing provides about 15% perception, seeing 60%. Don't stop with these. There is still 25% more reception to tune in on: touch, smell, taste and the emotions.

## Figure 7-2 continued

**Principle:** For education to be meaningful, it must do something for the student in the present. The future may be too far away to be meaningful.

### Application:

Education must pay off now! The fact that it will be helpful later is nice to know, but if education doesn't pay off in the present – the same type of education may not apply for the future. Education must be meaningful—not a promise. If you teach Algebra I because it is a need for Algebra II, the program is doomed to fail, since it provides no compensation right away; only a promise for a future goal.

**Principle:** An explanation of subject matter, even today, is composed of too large a proportion of words and too small a proportion of understanding.

### Application:

Come to class prepared. Know what and how you will present the subject. If you really know this, perhaps it will not take many words. Find better ways to present your subject, by minimizing on words, maximizing understanding.

**Principle:** Learning starts from an understanding of previous experiences upon which new ideas are built. During the transition ideas are built. During the transition process material things become less important, and meaningful verbal expression becomes more important.

### Application:

The beginning student needs a variety of activities. The retention span appears short. Use several activities to present the same material. For Example: present the abstract; validate the information by experiment. Then apply the theory, method of relating the experiment, to an actual application. In the laboratory the student tests the teaching, book, film, etc. In the application the teacher should test the student.

**Principle:** Learning is not obtained through a single inoculation: Once you've had it, you won't need it again. Booster shots are needed to assure continued proper response by the learning system.

### Application:

Don't expect the student to remember the facts just because you taught them once before. From time to time you must reinforce the information previously taught. Remember the bucket you are filling may have a slow leak. Some leaks may not be so slow.

**Principle:** Understanding human memory is quite complex. One thing is certain, unless a detail is placed into an organized structure, it is soon forgotten. The organized structure is a SYSTEM.

### Application:

Decisions can be made based on a broad conceptual understanding providing the known facts are all part of a system of walking, talking, eating and sleeping are all detailed, systematic processes. Without knowing the details the child is able to learn. Teachers, on the other hand, often feel the student won't understand unless he/she is first given all the details.

**Principle:** The development of a CONCEPT depends upon the study of the relationship between seemingly unrelated facts. The concept grows broader as these relationships come closer together.

### Application:

The learner may not see the relationship between seemingly unrelated facts. The teacher can show how these facts fit together so as to help the learner develop an overall understanding (a concept). The tighter the relationship is brought together the better the understanding of the concept.

## A Sampling of Teaching Methods

### Field trips

Utilize field trips for more than observation of technological processes. Use discussion and oral or written reports on the various occupations involved in the process observed. Bring back the experience with modern communications technology.

### Guest Speakers

Have one or more speakers address the class about past or present processes and occupations and the training and skills required. Have them discuss the rapidity of technological change and highlight emerging technologies.

### Student personnel system

When setting up the organizational chart, try to emulate industrial organization and procedure. Provide specific information on the occupations involved.

### Interviews

Require students to interview people involved in various occupations. Have them make written or oral reports to the class. Provide guidelines for the format of interviews. Include questions about how one best prepares for such employment.

### Bulletin board

The bulletin board can be an effective teaching method if used properly. Place items on the board that will stimulate interest and questions, something that will make them want to find out more, then provide students with a way to do so. Change your display often!

### Class discussion

Class discussions can be interesting and involving for students – if they are carried out in a non-judgmental manner. Listen to what students have to say and try not to dominate the discussion. Set up situations causing students to associate and make applications of the information presented.

### Role Playing

By means of simulated technological/industrial activity, role playing affords students the opportunity to identify with typical life activities as they exist in various occupations and/or professions. Through role playing, students can experience some of the reality of work responsibilities. It is especially well suited for use with enterprise laboratory activities, mass production activities, research and experimentation and group project experiences.

### Group project

The group project method involves the designing, planning and development of a product by a group of students. It differs from the mass production method in that only one (or a few) finished product(s) results from the activity of the group. Ideally, the project selected has numerous elements thus permitting the effective use of teams or other sub-groups. The method has been used successfully at the junior high level for studying high volume production industries such as paper and paper products, oil, iron, glass, and rubber. At the senior high level, the group project might take the form of designing and constructing a machine, vehicle prototype, or other large, even interdisciplinary, projects.

### Conceptual Learning

This approach is based on the notion that concepts have greater application to new situations than do specific facts. Current educational theory emphasizes the need to develop fundamental concepts and skills, which have functional value in a wide variety of applications. This learning generally is referred to as conceptual learning. For example, the concept of molding enables the student to relate general knowledge and skills to many specific types of industrial processes such as forging, foundry, and casting and in several material realms e.g. metals, ceramics, and plastics. A study of general or fundamental principles insures that loss of specific details will not mean a total loss. The remaining understanding will permit reconstruction of

details when necessary.

### Enterprise

The enterprise approach involves a simulation where students assume career roles and solve problems in a manner similar to their counterparts in industry. The enterprise method often involves such activities as research and development, financing, mass production, servicing, communication, transportation, distribution, and marketing. At elementary and junior high levels, the emphasis might be directed toward activities of simplified nature, since only limited time would be allotted for the activity. At the senior high level, activities may be more complex and greater emphasis is placed on tooling and higher technology.

### Cooperative work study

Many students enrolled in TE programs can profit from on-the-job experiences designed to supplement in-school learning. Such experiences assist students in further development of skills and positive attitudes toward work and school. Often work experience helps students in assessing and establishing career goals and this enhances their potential for successful employment in the future. Other significant out-of-school techniques include industrial observation and community projects. All out-of-school industrial experiences require supervision and evaluation by qualified school personnel to ensure that the experience and environment are adequately serving the student's educational goals and that safety and other safeguards are provided.

### Seminar

The seminar method emphasizes student interaction and contribution. It is used to identify individual problems and to provide for group assistance in finding solutions to these problems. The seminar provides a continuing opportunity for student peer evaluations as well as presentation of individual student progress. With the seminar method, the teacher(s) assume(s) the role of facilitator, observer, evaluator and advisor. In the seminar students become involved in challenging, questioning, assisting and discussing. The method has been used successfully in combination with the enterprise, group, interdisciplinary research and experimentation and other more traditional instructional methodologies.

### Individualized instruction

Individualized instruction provides for the varying abilities and interests of students. It involves development of self-instructional units or modules in a manner which enables students to be independent: (1) pre-assess their performance and knowledge of the objectives, (2) progress through specified learning activities at their own pace and (3) assess their own terminal performance and achievement of unit objectives. Missouri's TAMS capitalize on the benefits of this approach. A variety of hardware and software systems have been developed to facilitate management of the instructional approach. These include auto-tutorial systems, interactive video, programmed references, student contracts, learning activity packages, educational games, and computer-assisted instruction. All have great potential for helping students learn and consequently their use is strongly encouraged.

## **3 – Selecting Instructional Methods**

Technology and Engineering is concerned with technology, industry, its practices, procedures, and products. Within the classroom/laboratory, student experiences should be tailored to develop understandings, attitudes, and skills pertaining to technology rather than to the production of a take-home product (the project). Although a finished product may well be produced by each student, or by a group of students, it is important to remember that the project is not the goal but rather it is the by-product of the process of learning about technology and industry.

Curriculum content is not the only important element in the teaching-learning process. Because of the evaluated. Traditionally, many instructional methods have been used in technology and engineering programs. Methods such as lecturing, demonstrating, designing, problem solving, and constructing individual projects have long been recognized as effective instructional approaches for presenting content. These are being supplemented by emerging instructional methodologies which provide increased potential for devel-

oping technological, industrial, and career understandings, attitudes, and skills.

When developing TAMS and lesson plans for a program, it is essential to decide which teaching methods will be most effective. The instructor has many options, when selecting the appropriate instructional method for each student, and for each type of class. It is important that teachers use more than just those they learned while at college.

The following is a list of methods for adding variety and interest to technology and engineering programs. Combinations and permutations of this list are not only possible, but are desirable and should be encouraged. But methods alone will never be sufficient. The ultimate success of these as well as other techniques depends on the innovativeness, interest, and skill the teacher exhibits in presenting the material.

Community resources	Production
Conceptual learning	Conference
Research and experimentation	Show and tell
Contracts	Role playing
Cooperative Seminars	Student personnel system
Demonstrations	Discovery
Enterprise	Team teaching
Exercise approach	Group project
Field trip	Case study
Inquiry	Written or oral reports
Lecture	Work study
Mass production	Individualized instruction
Problem solving	Guest speakers

Instructional methods must be selected to capitalize on the unique needs of students in specific locales. The technology and engineering teacher must be alert to the resources of the community being served. Not only must teachers be alert to resources, they must also be aware of opportunities for integrating these resources into the instructional program. All resources such as speakers, industrial visitations, web sites, videos, slides, TAMS learning packages, and bibliographical resource materials must be evaluated on the basis of their merit to the instructional program. Figure 7-3 provides some useful guidelines for the selection of delivery systems.

**Figure 7-3**

**Guidelines for the Selection of Teaching Methods**

- ◆ The best procedure usually is to select the least elaborate and least costly strategy that will enable the learner to acquire the desired capability.
- ◆ All things being equal, well-illustrated, step-by-step verbal instructions, with feedback to the student constitute the most practical, effective, and efficient strategies for most types of learning.
- ◆ If an objective is accomplished in less time with one strategy than another, it is more efficient. If the retention or transfer of the information or skill learned is greater for one strategy than another, then it is more effective for reaching the objectives. When determining the approach to be followed, the best estimate of both efficiency and effectiveness will have to be followed.
- ◆ Try to select flexible strategies that can be adapted to student needs, problems, and interests.
- ◆ Strategies that give students an opportunity to share in goal-setting, learning experiences, and evaluation often produce better results.
- ◆ Students need to work with strategies that provide opportunities to inquire, to analyze, to explore, to be active, to create, and to initiate.
- ◆ The strategy selected should give the teacher an opportunity to observe student progress.

Individual preferences, ease for the instructor, and simple convenience, are not strong reasons for instructional choices. TE instructors also need to compare their decisions to state and national guidelines. The Missouri Technology and Engineering Program Self-Assessment Tool provides the details necessary for evaluating instruction. Instructors are advised to review their own decisions against these recommendations, keeping in mind that local differences and student needs may provide grounds for a departure from these standards.

#### **4 – Meeting Students Individual and Special Needs**

All students have individual differences and special learning needs. Traditionally, however, discussions related to special needs have centered on students with disabilities, but students with other individual differences must also be considered. Provision must be made for: educationally disadvantaged, economically disadvantaged, limited English proficiency (LEP), gifted students, and those with diverse cultural backgrounds. Additionally, students' preferred learning modes must be considered when planning instruction. Some students simply learn more, more efficiently and more effectively when presented information in visual, auditory, and kinesthetic means. Educational methods and procedures, instructional programs and materials, and school facilities must be modified for the purpose of individualizing programs and instruction to ensure that all students will develop to their fullest potential.

Federal legislation and teacher concern has provided the impetus to modify existing educational practices for learners with special needs. Such legislation is reflected in Public Law 94-142, the Education for All Handicapped Children Act of 1975 and its subsequent amendments, the Vocational Educational Amendments of 1976, sections 503 and 504 of the Rehabilitation Act of 1973, and more recently, the Carl D. Perkins Vocational and Applied Technology Education Act of 1998 and Public Laws 98-199, 94-198, and 101-476. The latter, the Americans with Disabilities Act of 1990 extends protection to adults. All of these laws emphasize the need to identify and infuse educational strategies designed to provide viable educational programs for special needs students. Furthermore, the legislation requires public education to provide instructional programs which will be the least restrictive educational alternative for students with disabilities.

##### **Identifying Special Needs Learners**

Technology and engineering professionals typically need not be concerned with detailed identification procedures for special needs learners, because they are the responsibility of other members of the education team. However, TE professionals should become familiar with some general characteristics of learners who are identified as "special needs" in order to better plan appropriate educational learning experiences and to contribute to the identification process when needed.

It should be recognized that the term "special needs" is an inclusive term which describes students with characteristics which may impede their ability to develop their maximum potential in unmodified programs. A broad understanding of the unique learning characteristics of students with disabilities, disadvantaged, limited English proficiency, or gifted/ talented will be helpful to TE professionals in modifying programs to accommodate students with special needs. The following material lists and describes characteristics pertaining to special learning needs.

##### **Learner Characteristics**

###### Disadvantaged

Disadvantaged students have academic or economic disadvantages which impair their ability to function in regularly structured school programs. These students typically may be members of families with low incomes, low or underachievers, from culturally restricted backgrounds or with limited English proficiency (e.g. unfamiliar with American customs or the English language). Generally, disadvantaged students are of normal or above intelligence but they fail to achieve in the regular school.

Academically disadvantaged students often display language difficulties, reading or writing prob-

lems, severe computational difficulties, or other general learning problems. These students may be frequently absent from school, have a short attention span and display low motivation when in class. They are often self-conscious, easily discouraged, have low self-esteem and express feelings of isolation.

Economically disadvantaged students typically are members of families whose incomes are below the national poverty level, have parents who are unemployed or are recipients of public assistance. Generally, these students exhibit many of the same behaviors as academically disadvantaged students.

### Limited English Proficiency (LEP)

Limited English Proficiency means individuals who were not born in the United States or whose native language is other than English; who come from environments where a language other than English is dominant; who are American Indian or Alaskan native students and who come from environments where a language other than English has had a significant impact on their level of English language proficiency; and who by reasons thereof, have sufficient difficulty speaking, reading, writing or understanding the English language to deny such individuals the opportunity to learn successfully in classrooms where the language of instruction is English or to participate fully in our society.

### Gifted and Talented

Gifted and talented students are those who, by virtue of outstanding abilities are capable of exceptionally high performance academically, physically, or creatively. However, these students will not live up to their full potential unless a challenging instructional environment is provided. The gifted also have unique needs and, as a result, they require enriched and challenging activities guided by a caring and stimulating teacher. In fact, unless they are challenged, these students' talent and creativity may turn toward disruptive behavior. Teachers should not assume that gifted children will be able to take care of themselves because of their superior intelligence.

### Students with disabilities

Students with disabilities are learners who have specific or general disabling conditions that may interfere with their functioning in a regular school environment. These disabilities may be sensory, physical, emotional, or any combination of the three. There are several terms used to classify students with disabilities. Among these are the mentally handicapped, hearing impaired, speech impaired, visually impaired, seriously emotionally disturbed, orthopedic impaired, other health impaired, deaf-blind, multi-disabled and learning disabled. Because of these impairments, students with disabilities may need special education and related services.

TE professionals will most often be providing educational experiences for those students who fit the category of "high-incidence" disabilities (i.e., those who comprise approximately 80% of the total population of students with disabilities). Among these students are students with learning disabilities, mild retardation, speech impairments, and mild- to moderate-hearing or visually impairments. These students have been able to achieve success in the regular school environment when provided with supportive services and modifications in educational curriculum and teaching strategies.

Occasionally "low incidence" children with disabilities may also be placed in regular TE programs. However, most will be placed in self-contained situations such as community-based instruction, supported employment, and specially designed vocational programs where their needs are more appropriately met. Among the students who fall into this category are those with severe and profound retardation and severe emotional disturbance. Individuals with profound deafness or blindness and orthopedic disabilities also fall into the low incidence category. However, because of their general learning potential some have been able to function successfully in regular access/barrier-free school programs.

The placement of low incidence learners in a least restrictive environment must be determined through an extensive evaluation conducted by qualified specialists. Generally, these special needs students will require support services in addition to an access/barrier-free building. Examples of such support include: interpreters, educational tutors/ aides and adaptive production jigs or fixtures.

The following provide a brief description of various disabilities. While not a totally inclusive listing, these characterizations will facilitate a better understanding for TE professionals of the general, physical, intellectual and social characteristics of students with disabilities.

- ◆ Individuals with "mild-moderate" mental retardation are those students who are capable of academic, social and vocational training, but who require specialized instruction to realize maximum skill development and meaningful integration into adult society.
- ◆ Individuals with "severe" mental retardation are those students who have potential for training in self-care, social adjustment, and vocationally-related areas rather than academic ones. During adulthood they may function effectively at home and/or in specialized situations such as supported employment and supervised living environments.
- ◆ Individuals with "profound" mental retardation are those students who are retarded to the extent that they are capable of very little self-care and often must have constant attention to survive.
- ◆ Students with learning disabilities have normal or above average intelligence but exhibit a specific learning disorder in one or more basic processes involved in understanding or using spoken or written language. Their learning problems are not due to visual, hearing, motor or environmental difficulties. Typical disorders which may be the cause of a learning disability are perceptual dysfunctions, brain injury, minimal brain dysfunction, dyslexia and developmental aphasia.
- ◆ Students with severe emotional disturbance or severe behavioral disorders exhibit undesirable behaviors or feelings over a long period of time that adversely affects educational performance. Students in this category have an inability to learn which cannot be explained by intellectual, social or health factors. School-related characteristics may include poor interpersonal relationships with peers and teachers; a general pervasive mood of unhappiness or depression; periods of self-stimulation or withdrawal; and a tendency to develop physical symptoms or fears associated with personal or school problems. The term includes schizophrenic individuals, most of who may profit substantially from instruction as determined through comprehensive and specialized evaluation.
- ◆ Students with visual impairments are handicapped in a normal educational program by their difficulty or inability to see. Under this heading, students are classified as partially sighted, legally blind or profoundly blind. However, many have demonstrated the ability to develop proficiency in using TE equipment with some modification of the learning environment.
- ◆ Students with partial sight or legal blindness are those who can learn to read print, but whose vision is limited (even with corrective devices), and who need instructional modifications in order to succeed in a regular educational program. Partially sighted persons have a vision of 20/70 to 20/200 after correction with lenses. Legally blind persons have less than 20/200 vision with glasses.
- ◆ Individuals with profound blindness have the most severe visual impairment. They cannot tell light from darkness and as a result, cannot see print. Often they can benefit from instruction in Braille. These students must depend totally on their other senses to function satisfactorily in an educational program.
- ◆ Students with orthopedic disabilities are normally limited in mobility, sitting and/or the use of tools and equipment because of muscular, skeletal or neuromuscular impairment. Included in the related causes of orthopedic handicaps are cerebral palsy, spinal bifida, and curvature of the spine, muscular dystrophy, hemophilia or other defects in legs, arms, neck or hips. Orthopedic handicapped students are generally average or above average in intelligence and can function in a regular school environment which has been adapted and made barrier / access free.
- ◆ Students with hearing impairments have a loss of hearing which affects their performance in a regular educational setting. Their sense of hearing is limited in many ways. For example, if students cannot hear the ordinary sounds of activity around them, then they are considered deaf.

However, when students can hear, but only hear part of what is said, then they are considered hard-of-hearing. Hearing losses may be mild, moderate, severe or profound.

- ◆ Individuals who are hard of hearing have some ability to hear and understand the spoken word. Although some words may be audible, the pitch and frequency of these sounds may make it difficult for these individuals to ascertain their meaning. Sounds are not necessarily just softer to these individuals but may also be garbled and distorted. Some hard-of-hearing students may require the use of hearing aids and/ or rely on lip reading. Likewise, deaf individuals must always require the use of an interpreter and/ or lip reading.
- ◆ Students with speech impairments normally have speech patterns which are noticeably different from the norm. There are many forms of speech impairment, ranging from complete inability to speak to minor articulator deficits. Furthermore, there are many causes for speech difficulties, ranging from delayed speech and hearing impairments to cerebral palsy and cleft palate.
- ◆ Students with other health-impairment are so categorized because they demonstrate limited strength, vitality and alertness. The conditions of these students are caused by chronic health problems such as heart conditions, tuberculosis, rheumatic fever, nephritis, hepatitis, asthma, epilepsy, leukemia or diabetes.
- ◆ Students with multiple disabilities exhibit combinations of two or more of the previously mentioned disabilities. For example, a student may be deaf and blind or orthopedic disabled and mildly retarded. As a result, special accommodations are necessary to facilitate their educational development.

### **Accommodating Special Needs Students in the TE Program**

Educational methods and procedures, instructional programs and materials and school facilities must be modified for the purpose of tailoring instruction to serve special needs students in TE programs. The teacher cannot accomplish this task alone. Other professionals from such areas as special education, rehabilitation, school psychology, guidance and the community in general can help. Through cooperative efforts TE programs can effectively incorporate the fundamental elements for success and therefore be as appropriate for special needs learners as they are for other students.

The teacher remains the central factor governing the special needs student's potential for success in TE. The teacher's attitude, personality and self-concept will help govern his/her performance. Teaching students from special needs populations is very much like working with non-special needs students. Each needs empathy, guidance/ direction, understanding and an appropriate and challenging learning environment carefully managed by a knowledgeable teacher. There are however, some subtle, as well as obvious, characteristics of certain learners that require a change of teaching style. For example, teachers who tend to "kid" or "tease" their students may find that students with poor self-image or low self-esteem may interpret this as "ridicule," "cruel," and "inappropriate punishment". Likewise, special needs students want "empathy" – understanding of their limitations and the desire to help remediate them (and also build upon strengths) – rather than "sympathy." Teachers must continue to be firm but fair, consistent and yet flexible, and concerned and caring enough to challenge special needs students to achieve new goals and experiences.

### **5 – Providing for Equity**

When discussing equity it is important to remember that the term encompasses more than just gender equity. It means being fair and impartial to people regardless of their sex, race, age, religion, or sexual orientation. Most materials that have been published recently have been revised to be unbiased and fair. Additionally, many references to aid the TE teacher in evaluating materials and practices on the basis of gender bias have been developed. Furthermore, most of the materials can be adapted to other equity targets if their terms related to gender are replaced with others related to race, religion, age, or sexual orientation.

Similarly, recruitment and program admission policies and procedures must be evaluated in order to eliminate any unnecessarily restrictive statements. Poorly phrased or overly restrictive policies could bias class participation in unintended ways. Course prerequisites, if any, must be examined in the same way to

determine if they are unnecessarily restrictive or are inadvertently prejudiced.

Change is a slow process and traditions are not relinquished easily. Technology and Engineering teachers must examine their own beliefs and assess their appropriateness. If they are dedicated to quality education for all students, TE teachers must remove those barriers that prohibit equity for all potential students. Though technology engineering has been an integral part of the school curriculum for more than three-quarters of a century, there are students, parents and school personnel who may not be aware of this fascinating and important area of the curriculum and its potential for non-traditional students.

Efforts to bring about a better understanding of TE will help everyone appreciate its benefits for all students. Commitment for reaching all students involves some concrete action such as examining attitudes and behaviors, carefully choosing instructional materials and making conscious efforts to help people outside the classroom become aware of the accomplishments made by Technology and Engineering. Figure 7-4 shows some of the strategies that will help in working towards increased equity.

**Figure 7-4**

**Equity Strategies for Classroom Teachers**

Be direct with students about bias. Point out racist or sexist bias in books or materials. Help them learn to identify sources of bias and important omissions in the materials.

Develop classroom activities around identifying bias found in television, textbooks, movies, library books or magazines.

Incorporate development of critical reading skills as instructional objective for all teaching, not just when special efforts are being made to identify bias in materials.

Identify or develop supplementary materials which can help "correct" some of the bias of available materials.

Assign student papers, themes, term papers or other activities on topics or persons not usually covered in textbooks or materials.

Invite local resource persons into your classroom to provide additional information and work with students on special projects and activities.

Ask students to rewrite materials or write their own materials on subjects omitted from the textbook or write the material from another person's point of view.

Use bulletin boards, posters, pictures, magazines and other materials to expose students to information commonly excluded from traditional materials.

Develop a classroom collection of non-racist/sexist reading materials for students. Identify books that students may be encouraged to seek out in their personal reading.

Be proactive in recruitment of nontraditional students and organize informational activities designed to attract nontraditional students.

Create a technology and engineering day where students in 6th or 7th grade can have hands-on experiences with technology.

Develop a video or web-based presentation targeted on non-traditional populations to encourage their participation in TE.

## **6 – Evaluating Student Performance**

Technology and engineering instructors are routinely expected to assess and document student progress toward their (and the program's) competency goals. Clearly, student evaluation is an integral part of teaching and with the implementation of instructional management systems it becomes even more important. Instructors should be careful not to allow themselves to consider evaluation as an intrusion, as something that takes away from instruction/learning time. Indeed, when properly handled, student evaluation will maximize the effectiveness of their instruction. To implement a systematic and effective evaluation scheme, instructors should note that:

- ◆ Evaluation involves assessing each student's progress toward documented course and individual

goals and objectives (such as the mastery of certain competencies).

- ◆ Feedback should be provided on a timely basis and in a constructive manner so as to encourage desired action.
- ◆ Self-evaluation by the student is an essential part of the overall evaluation.
- ◆ Each domain of behavior should be assessed by the evaluation system. Avoid one-dimensional evaluation (e.g., only knowledge or only psychomotor skills).
- ◆ There is a difference between evaluation and grading. The former ascertains the student's level of performance—the latter applies judgments to these assessments and links them to the system's grading scale.
- ◆ At the middle/junior high levels, considering the developmental stage of the students, those who make an effort but fall short should not be failed merely because a lack of knowledge, skills, or attitudes. At the same time, students should receive average or above average grades only for documented accomplishment.

### **Purposes for Student Evaluation**

Two major purposes guide teacher evaluation of student performance. They are typically called formative and summative evaluation:

- ◆ Formative evaluation is intended to have a shaping, guiding or other similar influence on students. It is administered before and/or during the learning process and as such it serves to give students feedback as to how they are doing. It is usually considered to be less threatening than other forms of evaluation. Often it is self-administered by the student and may not even need to be revealed to the instructor--depending on the maturity level of the student.
- ◆ Summative evaluation occurs at the end of some learning episode. This could be after a lesson, a major unit, a semester or a course. The purpose of this type of evaluation is to document how much and/or how well a student has mastered the target competencies at that given point in time.

### Pre-testing

Often instructors will want to pre-test their students prior to the beginning of a course or major unit. This is a highly recommended practice because it can tell them whether students:

- ◆ Have the prerequisite competencies necessary for success in the unit or course that is about to begin.
- ◆ Have mastered some or all of the competencies the unit or course is designed to develop.

The first readout can help the instructor identify and secure remedial help for deficient students. This can be used to bring weak students up to speed rather than slowing the entire class to accommodate their weakest member. The second readout would alert the instructor to allow advanced students to move at their own pace and reduce their likelihood of getting bored, disillusioned and/or disruptive.

### **Evaluation Techniques**

Just as in teaching, the richer the variety of methods used for evaluation, the richer the learning experience will be for the students. Effective TE instructors will employ a wide range of such techniques in addition to the standard observation, oral questioning and informal evaluation. Some of the more formal approaches include:

#### Module-based Testing

In programs using TAMs and other modules, instructors need to develop individualized evaluation systems that can be administered with a minimum of demand on teacher time for administration and grading. Typically this results in the use of combination of student self-assessment using product or process checklists, computer –based/scored testing, module progress/summary forms, or peer assessment. Often additional combinations of the following evaluation methods are employed.

### Progress Charts

These serve as a visible reminder to all students of their progress. If posted openly, it also shows how they compare to their classmates—a situation that has to be carefully monitored because of privacy issues. Progress charts can easily be used to track mastery of competencies in each domain although they tend to be used more frequently with skill or job accomplishment.

### Self- or Progress Checks

Especially when assigning more complicated and lengthy activities, it is desirable to encourage students to assess their own progress along the way. This is a lot better than having students find themselves short of the goal at the end of a long work period. Typically such progress checks are checklists of critical events or applicable criteria stated with enough detail and clarity that the student can assess his/her accomplishment of each step.

### Rating Scales

Most often used to evaluate a finished project, activity or attitude, these scales can be completed by either the student, his/her peers or by the instructor. Typically such a scale evaluates the work, according to established standards on a scale of 1 -5. Because of the standardizing effect such scales have, they help increase the instructor's objectivity across pupils and students. Additionally, if given to students in advance as is suggested, such scales help them learn and clarify what is expected of them. This is particularly important for affective performance measures. Such scales can also identify the weight placed on such criteria as:

- ◆ Accuracy and precision
- ◆ Finish
- ◆ Craftsmanship
- ◆ General design
- ◆ Degree of complexity / difficulty
- ◆ Time used
- ◆ Work habits
- ◆ Originality
- ◆ And many others.

### Achievement Tests

Sometimes these are considered appropriate only for the cognitive domain (i.e., what students know) but this is a mistake. Properly constructed performance tests are also excellent for validating mastery of psychomotor competencies.

Instructors should be careful to evaluate only against the clearly stated goals/objectives of a course, major unit or lesson. Such tests need to be developed to measure the appropriate level of performance in each domain. The most systematic manner to insure this is to use a table of specifications that indicates how many questions, and which levels, will be used to assess each objective.

Good tests must be valid and reliable. Validity is simply that a test measures what it is supposed to measure and not something else. Reliability is the characteristic that insures the results are the same each time people with the same capability are evaluated. Also, good tests must necessarily discriminate between students who have mastered the desired competencies and those who have not. Effective tests are moderately difficult, they are systematically representative of the objectives and content, they are clearly objective in their assessment and they are reasonable in terms of their length (time). To be assured of quality, it is recommended that TE instructors systematically establish the reliability and validity of their tests.

Instructors are advised to keep an ongoing bank of test questions and that each question be coded to an objective and to where the answer may be found, e.g., textbook page. Another desirable practice is to submit major unit and course tests to an item analysis program. This gives the instructor an excellent insight

into the quality of his/her test and thereby encourages refinement for the next time. With the increasing number of test-scoring machines in the schools, such programs are more easily available.

### Oral Test/Questioning

Typically this kind of evaluation is one of the mainstays of TE. It works well to check on reading and other homework assignments and as a preliminary review for major written tests. To increase objectivity and systematic coverage, it is recommended that instructors develop the questions and an answer key in advance of the administration of an oral test. Similarly a form for recording responses helps utilization of the oral questionings results.

### Improving Written Tests

Written tests can take many forms: true/false, multiple choice, matching, short answer and essay are among the most frequently used. Written tests should contain a sufficiently large number of the significant items selected from the content included in the course. They should include a variety of types of items each phrased in suitable vocabulary with an appropriate range of difficulty. Tests should be attractive and easy to read. Drawings and sketches may be used effectively in test items and they may help to make the test interesting to the student. Test directions should be brief, but definite.

Items used on written tests generally fall into three categories: essay, recall and recognition. Multiple-choice, true-false and matching items are of the recognition type while listing and completion items are of the recall type.

- ◆ The essay type of item requires that a student understand the subject matter thoroughly and express this knowledge in written form. When essay items are used, care should be taken that the topic is of major importance to the course. Since a considerable amount of time is required to write an essay answer, this type of examination usually involves a limited sampling of the total area of instruction. Subjective judgment is required in the scoring of essay type answers. However, a careful analysis of the material encompassed in the item and the preparation of a rating scale may help to make scoring of these items more objective. The instructor should be alert to the writing ability of the student when he/she uses essay tests.
- ◆ Recall items require the student to complete a statement, supply an answer to a question, or list certain items. The answer may involve simple facts or concepts that are of importance to the work, or may require the solution of a problem which applies these concepts. Scoring of items of this type requires reading the answers and applying judgment in cases where several different words could supply the same meaning. This task is easier if spaces for the answers are placed at the left of the page rather than in the text of the items. If separate answer sheets are used, they should be ruled or printed to provide uniform spacing for the answers.
- ◆ Recognition type test items require that the student select a response from a number of given possibilities. Properly constructed recognition type items provide a desirable means of objective testing, since the respondent must choose one correct or best answer. Recognition type items lend themselves well to the use of printed answer sheets, perforated scoring masks and computer scoring (added).

Students may guess right answers for recognition items; however, the effects of guessing are decreased as the number of items in a given test is increased. A true or false test should contain at least fifty items to reduce the effects of guessing. The guessing factor in multiple choice or matching items is less important if four or five plausible choices are provided.

### Grading

After evaluation mechanisms are employed TE instructors face the challenge of converting these results into a grade. This is typically a difficult task because it involves a considerable amount of professional judgment. Here the instructor must be careful to be:

- ◆ Fair to students regardless of their personal feelings.
- ◆ Consistent from class to class.
- ◆ Systematic in assessing all desired dimensions of performance.
- ◆ Accurate to avoid mistakes.
- ◆ Free from bias of any kind.

One of the best ways to meet such high criteria is to carefully document the evaluation criteria and grading system. When looking at a system on paper, the errors and weak assumptions just seem to "jump out" at you.

(See appendix B for National Student Assessment Standards)

## **7 – The Career and Technical Student Organization (CTSO)**

The concept of an organization designed to support students learning a vocation had its roots in the activities of such institutions as trade guilds and apprenticeship societies common in the 18th and 19th centuries. In more contemporary history, the development of career and technical education (formerly vocational education) and the career and technical student youth organization (formerly vocational student organization) can be chronicled through a number of relevant Federal laws. The information below outlines the federal role in career and technical education from current law back to its inception in 1918.

### **Carl D. Perkins Vocational and Technical Education Act of 1998**

The 1998 Perkins Act, an updated version of 1984 and 1990 Perkins laws, is the vehicle for providing federal support for career and technical education. Targeting primarily programs for high school students and postsecondary students attending community and technical colleges, the Perkins Act lists four basic purposes: (1) to build on the efforts of states and localities to develop challenging academic standards; (2) to

develop services that integrate academic and technical instruction and that link secondary and post-secondary career and technical education; (3) to increase state and local flexibility in providing career and technical education programs, including tech prep; and (4) to disseminate national research and provide professional development and technical assistance to improve career and technical education. The Perkins Act specifically includes career and technical student organization activities as allowable at the state and local level. (from “The Official Guide to the Perkins Act of 1998” by the Association for Career and Technical Education)

Career and Technical Student Organizations: A Reference Guide, Second Edition 1999, US DOE

### Vocational Educational Act of 1963

This act and its subsequent amendments of 1968 and 1976 specified that vocational student organizations were an essential part of vocational instruction; vocational education, therefore, became a legitimate recipient of federal and state grant funds for the purpose of providing leadership and support to vocational student organizations and applicable and appropriate activities. (from “The National Association of the Vocational Industrial Clubs of America: Development of a National Organization,”

1965-1990 by Karen Hale) 9 8

### Public Law B1-740 (1950)

This law, referred to as Public Law 740, federally chartered a vocational student organization, thereby establishing the relationship of a vocational student organization to industrial arts education. It also officially tied the U.S. Office of Education to vocational student organizations by allowing employees of the U.S. Office of Education to be hired for the purpose of working with student organizations. Although this law chartered only one student organization (the vocational agriculture student organization), it established the pattern of treating existing and future vocational student youth organizations as integral parts of voca-

tional education. (Ibid.)

### “George Acts”

These acts (1929, 1934, 1936, and 1946) were a series of laws that supplemented and continued the appropriations for vocational education started by the Smith-Hughes Act. Of the four acts, the most important to youth organizations was the George-Barden Act of 1946, also known as the Vocational Education Act of 1946. This act was the first to mention a vocational student organization by name, and it specifically stated that funds could be used for vocational agriculture teacher activities that were related to the vocational agriculture student organization. (Ibid.)

### Smith-Hughes Act (1918)

This act, often referred to as the “Granddaddy Act” of vocational education, in effect provided the foundation for vocational student organizations. Although the act did not specifically mention student organizations, it provided funds for vocational agriculture teachers whose duties included advising and supervising a vocational student organization. (Ibid.)

Today, the career and technical student organization (CTSO) is regarded as an integral part of career and technical education. There are ten CTSOs recognized by the U.S. Department of Education (see Section 3). These organizations provide a unique program of career and leadership development, motivation and recognition for secondary, post-secondary, and adult and collegiate students enrolled, or previously enrolled, in career and technical education programs. Educators have found that the CTSO is a powerful instructional tool that works best when it is integrated into the career and technical education curriculum by a trained professional. The dedicated instructor provides organized curriculum-oriented activities that help students gain career, leadership, and personal skills that maximize employability and the ability to become productive citizens in the workforce, home and community.

The ten CTSOs recognized by the U.S. Department of Education are:

PBL	Business Professionals of America -- Phi Beta Lambda
DECA	Distributive Education Clubs of America
FBLA	Future Business Leaders of America
FCCLA	Family, Career and Community Leaders of America
HOSA	Health Occupations Students of America
FFA	National FFA Organization
NYFEA	National Young Farmer Educational Association
PAS	National Postsecondary Agricultural Student Organization
SkillsUSA	SkillsUSA
<b>TSA</b>	<b>Technology Student Association</b>

## **8 – Developing Employability Skills**

Employability skills refer to competencies possessed by individuals which allow them to get and keep a job. Occupational skills associated with specific jobs are not employability skills. Rather, what is being referred to are things such as dependability, punctuality and general work attitudes. Typically employability skills involve competencies in three primary areas: personal characteristics, job seeking techniques and entrepreneurship awareness.

Why should employability skills be of concern to TE teachers? There are several reasons. Many TE students will go on for further training in vocational education programs and the skills learned in TE will make it a great deal easier for them to succeed. Many students find work after high school and will be in

need of these skills in order to keep their job. Some students work part time while going to school and employability skills make it possible. Still other students drop out of formal education and attempt to find work on a full time basis. Without these skills they are likely to be doomed to failure.

There are three major components of employability skills education. Skills needed to get a job, and skills necessary to keep a job are the first two. Both are equally important and neither should be overlooked. It stands to reason that in order to keep a job you must first get one. Conversely it does little good to get a job if you can't perform well enough to keep it. The third component, entrepreneurship awareness, represents job creation for oneself, rather than working for someone else.

The first order of business for anyone looking for work should be the acquisition of job seeking skills. Sample questions to ask when planning employability skills instruction are:

- ◆ How do you apply for a job over the phone?
- ◆ How do you answer a newspaper advertisement of a job?
- ◆ How do you interview for a job?
- ◆ What type of clothing should be worn to an interview?
- ◆ What information should be included in a resume?
- ◆ Are there any techniques that will make interviews easier?
- ◆ How is a job application form completed?
- ◆ Who and what are personal references?
- ◆ What should be done when offered more than one job?
- ◆ What criteria should be used to evaluate job offers?

Other than specific occupational skills, several personal qualities have been identified that employers expect and demand of employees. Employability skills are learned and can be taught in a systematic, logical manner. Some of these competencies are:

- ◆ Punctuality
- ◆ Dependability
- ◆ Reliability
- ◆ Being cooperative
- ◆ Showing initiative
- ◆ Perseverance
- ◆ Demonstrating respect for others
- ◆ Willingness to learn
- ◆ Personal hygiene
- ◆ Ability and willingness to follow directions
- ◆ Ability to get along with co-workers
- ◆ Ability to be self directive and complete tasks unassisted
- ◆ Ability to communicate with others
- ◆ Ability to accept, and profit from, criticism
- ◆ Technological capabilities commensurate with the job

## Bibliography

Boben, D. K. (1985). Guidelines for equity issues in technology education. Reston, V A: ITEA.

Buffer, J. J. Jr., & Scott, M. L. (1985). Special needs guide for technology education. Reston, V A: ITEA.

Clendenning, L. R., & Dickey, O. W. (1983). Technology, free enterprise, and careers through industrial arts. Preliminary Draft. Mount Berry , GA: Berry College & Georgia State Education Dept.

Miller, W. R. (1990) Instructors and their jobs. Homewood, IL: American Technical Publishers.

Tischler, M. (N .D.). Thoughts on learning: Concepts for planners, supervisors, teachers, writers, salesmen. Baltimore MD: Science Instruments Co. (6122 Reisterstown Road, Baltimore, MD 21215-3487).



## **Chapter 8 – Organizing and Managing a Technology and Engineering Program**

## Chapter 8 Organizing and Managing the Technology and Engineering Program

### 1. — Introduction

“Even the best laid plans can go astray!” To be sure, but when they do it is most

often a problem with organization, management and follow-up. Typically, the TE instructor’s ideas are sound and well-founded—but, if when problems arise, it is his/her action or follow-through that is lacking—and often not due to any personal failing but rather because of a lack of support. Consequently, this chapter’s intent is to help TE instructors organize and manage programs more effectively. As such, this chapter shares the collective experience of the profession’s best practitioners.

To this end, this chapter’s main parts present guidelines to help find and make effective use of key resource people, to use available support systems, to use advisory committees to achieve the TE program’s goals, and to organize and manage the program better. Properly organized and managed, these resources will help students achieve more—and with less strain on your part.

### 2 — Accessing Key Resource Personnel

It is impossible for anyone to be all things to all people. This is especially true in the world of technology with its exponential rate of growth and change. Therefore the TE teacher must be aware of key resource personnel who are available to offer assistance. Typically nine categories of resource people are used most often.

- ◆ Local school and school system personnel

Supervisors	Principals
Superintendents	Counselors
Specialized. Teachers	Vocational Resource Person
Peer Teachers	

- ◆ Other local, state and national members of the profession
- ◆ University faculty
- ◆ Department of Elementary and Secondary Education (DESE) personnel
- ◆ Other Missouri state departments/divisions in related areas, e.g., the Departments of Health and Human Services, Economic Development and the like
- ◆ Educational association/staff members
- ◆ State and national special focus groups
- ◆ Individuals employed in technology (business & industry)
- ◆ Professionals in the community

#### **DESE Personnel**

The Missouri Department of Elementary and Secondary Education (DESE), also offers a great deal of assistance. DESE staff have a wide range of contacts with other schools, both within the state and beyond it. Questions about what to teach, with what methods and how well these methods work are most appropriate for them to field as are questions about what is happening elsewhere.

#### **University Faculty**

Similarly, the state colleges and state universities (as listed in Figure 8-1) all provide excellent sources of information. Technology personnel within these institutions have wide experiences with all types of technology and programs. Their faculty have diverse backgrounds, considerable professional involvement and they often conduct research in areas of special interest on a regular basis. They frequently offer

seminars, courses, workshops and many types of in-service programs. Figure 8-1 lists the names of colleges and universities in Missouri, along with department titles, addresses and phone numbers. Universities in other states are found in the Industrial Teacher Education Directory.

<b>Figure 8-1 Missouri Universities with TE Programs1</b>	
<b>Lincoln University</b>	
Jefferson City, MO 65101	
<b>Missouri Southern State University</b>	
Joplin, MO 64801-1595	
Dept. of Engineering Technology,	Phone (417) 625-9567
<b>Missouri State University</b>	
Springfield, MO 65804,	
Dept. of Agriculture,	Phone (417) 836-5638
<b>Southeast Missouri State University</b>	
Cape Girardeau, MO 63701	
Dept of Industrial & Engineering Tech.,	Phone (573) 651-2104
<b>University of Central Missouri</b>	
Warrensburg, MO 64093	
Dept. of Career & Technology Education,	Phone (660) 543-4452
Dept. of Graphic Imaging & Design Tech.,	Phone (660) 543-4727
Dept. of Industrial Technology,	Phone (660) 543-4439
Dept. of Safety Science and Technology,	Phone (660) 543-4626

### **Business & Industry Personnel & Associations**

Professional trade associations involved with any facet of any particular technology in question are other logical and important sources for help. These associations are found at local, state and national levels. Don't forget any of them. Much valuable assistance can be gotten from these sources. Figure 8-2 presents a sample of such organizations. TE instructors can identify additional appropriate associations by consulting the Encyclopedia of Associations or other association directories in the reference section at their nearest library.

Don't forget business and industry or the local community's professionals either. Frequently equipment, supplies and other materials are available just for the asking. Business and industry like to help education because the schools supply them with skilled manpower. Some of these contacts are, or should be, members of your advisory committee. Use these contacts regularly on both a formal and an informal basis. Show up at their places of business, just to be friendly, from time to time. Don't just show up or phone only when you want something. Offer your services when it is feasibly for you to be of assistance to them and their firms. This type of partnership is one of sharing and cooperation and should be one of mutual benefit.

### **Government & Education Association Personnel**

State and Federal government agencies in specific service areas can be of immeasurable assistance with problems in their area of expertise. Typically, the types of things that will be involved will not necessarily be technological in nature, although, they may involve technology, industrial, medical or some other kind. After all, technology pervades virtually every aspect of human endeavor. Some of the government agencies that can provide assistance are presented in Figure 8-2.

Educational associations on the local, state and national level can be of assistance in many ways. They offer publications, conferences and special-topic workshops and seminars. Membership in this type of association is highly recommended and it can pay off in dividends for students, faculty and the entire school district. Figure 9-4 lists some of the associations of relevance to TE.

<b>Figure 8-2 Federal and State Agencies</b>	
<b>Federal</b>	
The U.S. Department of Education 400 Maryland Ave, SW Washington, DC 20202 Phone: (800) USA-LEARN Web: <a href="http://www.ed.gov/index.jhtml">http://www.ed.gov/index.jhtml</a>	Center on Education and Training for Employment The Ohio State University 1900 Kenny Rd. Columbus, OH 43210-1090 Phone: (800) 848-4815 Web: <a href="http://www.cete.org/">http://www.cete.org/</a>
National Research Center for Career and Technical Education (NRCCTE) University of Louisville College of Education and Human Development Louisville, KY 40292 Phone: (502) 852-4727 Web: <a href="http://www.nrccte.org/">http://www.nrccte.org/</a>	Environmental Protection Agency Farmers Home Administration Nuclear Regulatory Commission The Dept. of Health and Human Services National Aeronautics & Space Administration Department of Transportation
<b>State</b>	
Missouri Center for Career Education University of Central Missouri T.R. Gaines 302 Warrensburg, MO 64093 Phone: (660) 543-8768 Web: <a href="http://www.mcce.org/">http://www.mcce.org/</a>	Missouri Council on Career Technical Association Web: <a href="http://www.mccta.org/">http://www.mccta.org/</a>
Missouri Economic Research and Information Center P.O. Box 3150 Jefferson City, MO 65102-3150 Phone: 1-866-225-8113 Web: <a href="http://www.missourieconomy.org/">http://www.missourieconomy.org/</a> Email: <a href="mailto:MERICData@ded.mo.gov">MERICData@ded.mo.gov</a>	Missouri State Agency for Surplus Property 117 N. Riverside Dr. P.O. Drawer 1310 Jefferson City, MO 65102 Phone: (573) 751-3415 Web: <a href="http://oa.mo.gov/purch/surplus.html">http://oa.mo.gov/purch/surplus.html</a>
Division of Vocational Rehabilitation Division of Employment Security Division of Family Services	Governor's Committee on the Employment of the Handicapped Job Development and Training Program Department of Health Depts. of Labor and Industrial Relations Wolfner Memorial Library (for the blind and physically handicapped)

The main two TE associations are the (Association for Career & Technical Education's (ACTE) Technology Education Division and the International Technology Education Association (ITEA). Both offer extensive benefits and programs of service to their members. In fact, many in the profession belong and actively participate in both. The Technology Education Association of Missouri (TEAM) serves as the state's representative for both national associations. The Missouri Association of Career & Technical Education, the state's ACTE affiliate, has a Technology Education Division which provides programming and an interface to the vocational education system.

The International Technology Education Association (ITEA) and the ACTE's Technology Education Divisions are the profession's voice for technology and engineering. Their purpose is to enhance service to youth. Their primary concerns involve the evolution of curriculum and personnel in the profession.

Their programs for teachers, students and supervisors are based on the premise that technology and engineering is vitally significant in a world where industry and technology are critical to every aspect of our life. Both state and national associations work to secure federal funding for technology and engineering programs and both have received recognition from the U.S. Department of Education.

The Technology Education Association of Missouri deserves special mention because it is our state’s key professional association. Essentially the work of this association is conducted by an elected board of directors and by committees they appoint. The former is representative of the state’s eleven regional TE associations. Some of the TEAM’s main activities include:

- ◆ Issuing a regular newsletter/magazine.
- ◆ Conducting the annual regional and state Technology and Re-engineering Awards program and Exposition for student skill and knowledge.
- ◆ Organizing professional development conferences several times each year (including the TE program at the MoACTE’s July conference.)

State and national special focus groups are associations of individuals with concern for specific groups of individuals. Among these groups are the handicapped, disadvantaged, blind, autistic and minority groups.

<b>Figure 8-3 Professional Associations Relevant to TE</b>	
International Technology Education Association (ITEA)* 1914 Association Drive Reston, VA 20191-1539 Phone: (703) 860-2100 URL: <a href="http://www.iteaconnect.org/">http://www.iteaconnect.org/</a>	Epsilon Pi Tau Bowling Green State University 101 Technology Bowling Green, OH 43403 Phone: (419) 372-2425
ITEA - Council on Technology Teacher Education ITEA - Council for Supervisors ITEA - Technology Education Collegiate Association ITEA - Technology Education for Children Council	Missouri National Education Association (MNEA) 1810 E. Elm St. Jefferson City, MO 65101-4174 Phone: (573) 634-3202
Technology Student Association (TSA) 1914 Association Drive Reston, VA 20191-1540 Phone: (703) 860-9000 URL: <a href="http://www.tsaweb.org/">http://www.tsaweb.org/</a>	Missouri Congress of Parents and Teachers (PTA) 2101 Burlington St. Columbia, MO 65202-1997 Phone: (573) 474-8631
Association of Career & Technical Education (ACTE) Technology Education Division* 1410 King St. Alexandria, VA 22314 Phone: (800) 826-9972 URL: <a href="http://www.acteonline.org/">http://www.acteonline.org/</a>	Missouri ACTE 213 E. Capitol Ave. P.O. Box 1955 Jefferson City, MO 65102 Phone: (573) 634-7366 URL: <a href="http://www.mo-acte.org/">http://www.mo-acte.org/</a>
Missouri Federation of Teachers (MFT) 208 Madison St Jefferson City, MO 65101 Phone: (573) 635-0073	Technology Education Association of Missouri (TEAM)* and its regional associations* URL: <a href="http://www.moteam.org/">http://www.moteam.org/</a>
Missouri State Teachers Association (MSTA) 407 South Sixth St. P.O. Box 458 Columbia, MO 65202 Phone: (573) 442-3127; (800) 392-0532	Technology and Engineering State Supervisor Missouri Department of Elementary and Secondary Education (Mo DESE) 205 Jefferson St. P.O. Box 480 Jefferson City, MO 65102-0480 Phone: (573) 751-7764 Email: <a href="mailto:W.Doug.Miller@dese.mo.gov">W.Doug.Miller@dese.mo.gov</a> URL: <a href="http://dese.mo.gov/divcareered/tech_ed_index.htm">http://dese.mo.gov/divcareered/tech_ed_index.htm</a>

## **School Administration**

Perhaps no personnel are as pivotal to the success of the TE program as are the members of the school's administrative team. Here is where degrees of freedom are enlarged or restricted. Instructors must be certain to work carefully and systematically to build administrative support.

### **3 – Using Available Support Systems**

Available support systems are closely related to the previous topic that highlighted resource people. Key resource personnel are a vital component of any support system. There are, however, some support systems that are not necessarily represented by individuals. Some of these include: state department of education programs, federal programs and physical plant services.

The Missouri Department of Elementary and Secondary Education offers, on an annual basis, the Technology and Engineering Grant Awards Program (TE GAP). Guidelines are issued yearly to help TE instructors apply for these funds. Typically they are earmarked for program improvement in Technology and Engineering programs. In the past, such funds have been available for exemplary programs, innovative teaching methods, equipment, supplies, copying and dissemination of successful practices. It is strongly recommended that TE instructors take advantage of this funding to supplement local resources. This enables a more rapid implementation of program change/updating in order to better reflect rapidly changing technologies.

#### **Guidance Support**

One of the support systems crucial to the success of TE programs is the school's guidance support. For maximum program effectiveness, formal and cooperative relationships are vitally important.

### **4 – Using Partnership Advisory Councils**

Partnership and Advisory committees at the state and local level should help educators determine the nature, content and activities of each course. In addition, they can provide valuable input regarding the facilities required to implement the program. Local committees are helpful in determining community needs and in identifying the human and material resources available from within the community and local industry.

Although it is important to note that such councils are not policy or decision making groups, their services are valuable and should be given every consideration. But finally, it is the responsibility of the TE instructor and the school's administration to decide whether (and how) the recommendations are to be implemented.

Local partnership/advisory councils may be the single most important source of information and assistance available to the TE teacher. Considerable assistance can be obtained from these councils. However, in interaction with state and national advisory council an even broader perspective on programming, industrial needs and available resources is available.

One overall partnership/advisory council should be established for the TE program. If the school has a career or community advisory council/group/organization, then it is important that a representative from the TE partnership/advisory committee serve on the other advisory group for liaison and coordination purposes. Similarly, one TE partnership and advisory council member should be designated to establish a correspondence link with the national Technology Education Advisory Council. Such correspondence should be directed through the ITEA national office. Another member should keep in touch with Missouri's Council on Career Education.

#### **National Technology Education Advisory Council**

At the National Level, the Technology Education Advisory Council (TEAC) was established to provide information to the technology education profession about current developments and possible trends in

technology education. As such, the TEAC services to:

- ◆ Recommend ways of resolving discrepancies between the programs and philosophies of technology education and current industrial/technological practices.
- ◆ Recommend content directions to improve the relevance of technology education.
- ◆ Suggest methods of improving the public's perception and understanding of technology education.
- ◆ Facilitate the cooperation between industry and education to improve the education of youth.

The TEAC's recommendations are advisory since the council has no official policy-making authority. The council's topics of discussion vary as the association's membership suggests or as requested by the ITEA's Board of Directors – the TEAC's sponsoring group.

### **Local TE Partnership Advisory Council**

The duties of local technology and engineering partnership advisory councils are to counsel and advise TE instructors, supervisors, school administrators and the school board concerning the directions, management and supervision of the TE program. Generally these councils also assist in the development and maintenance of the TE curriculum and facility.

Local partnership advisory council provide community and industrial input to teachers and counselors. They are not policy or decision-making groups, rather they advise by reviewing policies and programs, by expressing opinions on programs, services, facilities and learning activities and by identifying trends, priorities and resources. It is recommended that such council be asked to submit an annual report as well as such special reports as appropriate. It is also important that the advisory council addresses the TE program's relationship to the overall school curriculum. Other recommended partnership advisory council activities include:

- ◆ Making recommendations regarding program content and needed curriculum, equipment and facility changes.
- ◆ Providing information and technical assistance necessary to update the program.
- ◆ Assisting in developing performance objectives.
- ◆ Assisting in developing and conducting community surveys.
- ◆ Providing with information regarding new career opportunities.
- ◆ Assisting in obtaining community resources.
- ◆ Assisting in the development and promotion of good public relations.
- ◆ Assisting in the evaluation and review of the program (Towler, p. 75).

### **Local TE Partnership Advisory Council Membership**

There is no answer to the optimum size of an partnership advisory council. Each council should be comprised of member representative of the community it serves. Normally however, about seven members (less in small communities) will provide adequate coverage of geography, minorities and industries within a given community. The following should provide helpful guidelines for selecting council members.

Industry representatives, e.g.:

- ◆ One individual from the communications industry.
- ◆ One from energy/power.
- ◆ One from materials processing industry.
- ◆ One TE educator.
- ◆ One or more parents (can be identified by the local PTO).
- ◆ One or more students (at least one should be female).

- ◆ One representative from the school or system’s administration.
- ◆ One individual representing career education.
- ◆ One specialist in the area of special needs populations.

Some method of membership rotation should be devised prior to the actual formation of a council. Fresh viewpoints and ideas are essential to properly address our rapidly changing technological world. For this reason, only under exceptional circumstances should the reappointment of a committee member be considered. One workable way to address the rotation of committee members is to make their initial terms of varying length – typically one, two and three years are used.

Advisory council could of course use consultants, on a temporary basis, to assist in solving specific problems. Specialists in areas outside of the committee’s areas of expertise can serve on a temporary basis until a specific problem or concern is adequately addressed. If this arrangement is used the consultants would not have voting privileges in council matters. Their services would be on a strictly consulting basis.

### **Local TE Partnership Advisory Council Operations**

#### Selection of Officers

Each partnership advisory council should elect a chair and a secretary. It is recommended that a teacher or administrator not serve as chair, but may serve as secretary.

#### Officer Duties

The chair:

- ◆ Shall call and preside at all council meetings.
- ◆ Shall schedule all meetings and make necessary council assignments.
- ◆ Should prepare an agenda for each meeting.
- ◆ The secretary:
- ◆ Will record, maintain and distribute minutes of every meeting to each member of the council.
- ◆ Is responsible for notifying members of the meeting date, time and place.
- ◆ Should provide all members with an agenda and issues to come before the council prior to the meeting, preferably one week in advance.

#### Meetings

It is recommended that:

- ◆ The initial meeting be held within thirty days following appointment of the council. The superintendent, or a representative, should call this meeting and preside until a chair is selected.
- ◆ The committee members be acquainted with the purpose and duties of the council.
- ◆ Council meetings be planned for specific purposes. Behymer’s guide provides an excellent outline for a program to work.
- ◆ Regular scheduling of meetings be determined by membership, based on existing problems and important matters for consideration.
- ◆ The council should establish its own governance rules.

### **The School’s Responsibility to Partnership Advisory Council Members**

Council members should be informed, by an official letter from the superintendent of schools, that membership is an official act which has state approval. The council and school administrators should work in harmony to serve a definite purpose. Council members must be advised that they are resource persons to improve curricula, facilities, teacher preparation, occupational information, community surveys and public relations. (Towler, p. 76)



## **Chapter 9 – Technology and Engineering Program Evaluation**

## **Chapter 9**

### **Technology and Engineering Program Evaluation**

#### **1 – Introduction**

There are basically three types of evaluations a TE program can undergo: Local (internal) evaluation, school accreditation and state evaluation. Each Evaluation serves a different purpose but all focus on program improvement.

#### **2 – Local (internal) Evaluation**

These evaluations focus on the improvement of instruction and are conducted by school personnel. Such “in house” evaluations are often conducted three to five years. This type of evaluation should not be informal and incidental, but rather formal in nature. In other words the process should be conducted on a formalized, scheduled and official basis with the results recorded for the board of education’s review. These internal program reviews allow school personnel to make adjustments to programming, facilities and equipment, often with the guidance of the TE partnership advisory team. The Missouri TE Standards (available from Missouri’s TE Supervisor) are an excellent basic framework for this kind of evaluation.

#### **3 – School Accreditation**

Missouri schools may elect to pursue external and/or state accreditation. The North Central Association of Schools and Colleges (NCA) provides the mechanism for external accreditation. The accreditation process is voluntary and thus is quite flexible in permitting local procedures to vary considerably. However the basic elements and sequences are typically similar. They involve:

1. A request for accreditation to NCA
2. Conduct a self-study that involves:
  - ◆ Formation of a local committee
  - ◆ Self-evaluation of each program (TE is one)
  - ◆ Self-evaluation of school-and community-wide functions
  - ◆ Compilation of appropriate documentation
3. Establishment of a visiting team
4. Visiting team’s review of self-study as prepared by the school’s local team
5. Visiting team’s on-site visit including:
  - ◆ Program by program review
  - ◆ Overall function review
  - ◆ Validation of documentation
  - ◆ Exit report
6. Visiting teams report of findings
7. Visiting team leader and local committee interaction establishing required follow-up
8. One year follow-up of required action.

It is important for TE instructors to consider such accreditation procedures as an opportunity—not a threat. Often such accreditation reports provide the kind of support that secures long-needed improvements. To facilitate this it is strongly encouraged that the local TE instructors nominate two or three highly respected technology educators to serve on the visiting team. Don’t just select friends or colleagues who you think would be “easy” on the program.

The NCA does not mandate any given set of evaluation instruments. Instead it encourages local in-

stitutions to use standards of “appropriate professional organizations.” To ease matters however, the NCA provides a set of evaluation criteria that are produced by the National Study of School Evaluation (NSSE). Because of the national process used, such criteria lag somewhat behind the profession’s pulse so these criteria do not necessarily represent the profession’s current thinking. Therefore it is recommended that for accreditation purposes, local schools update the NSSE criteria with the Missouri Technology and Engineering Program Standards and Quality Indicators Self-Assessment Tool (available from Missouri’s Supervisor of TE). The combined use of these two sets of criteria would make for an exceptionally strong self-evaluation.

**4 – Missouri Technology and Engineering Program Standards and Quality Indicators self-assessment tool**

Missouri’s Department of Elementary and Secondary Education recommends that all TE programs be evaluated every 3-5 years. For programs receiving special state and/or federal funding, such evaluations typically need to be conducted at least once every five years. The current program for such evaluations is called the Missouri School Improvement Program.

As with accreditation procedures, it is recommended that state evaluations begin with a systematic self-evaluation. To help in this, Missouri DESE’s technology and engineering section provides the Missouri Technology and Engineering Program Standards and Quality Indicators self-assessment tool. They were subsequently endorsed by the Technology Education Association of Missouri (TEAM). State evaluation also involves a visiting team’s on-site evaluation. As with accreditation assessment, it is strongly recommended that TE instructors present a fair and complete picture of their program’s strengths and weaknesses.

**The Missouri Technology and Engineering Program Standards**

STANDARD 1.....	Curriculum Planning, Organization, and Content
STANDARD 2.....	Instructional Materials
STANDARD 3.....	Instructional Personnel
STANDARD 4.....	Program Enrollment
STANDARD 5.....	Career and Technical Student Organization
STANDARD 6.....	Instructional Facilities and Equipment
STANDARD 7.....	Safety Education and Practices
STANDARD 8.....	Community Support and Involvement
STANDARD 9.....	Program Management and Planning

**5 – Program Planning Quality Control**

TE instructors who update their programs or who plan new ones often want to know if their plans align with the generally accepted standards of the profession. One efficient way of double-checking one’s work is to use the Missouri TE Standards and Quality Indicators Program self-assessment tool.

**180-Day Follow-up Evaluations with Former Students**

As part of any of the types of evaluations (local, accreditation, state) a follow-up of students can provide many useful insights. Therefore it is recommended that each TE program conduct and maintain careful records of a follow-up of its students. Such a study should record:

- ◆ Data descriptive of the students flowing through the program, e.g., age, gender, GPA, socio-economic status, career aspirations, educational plans, test scores.
- ◆ Data showing what kind of educational experiences students had after participating in the TE program.
- ◆ Data showing what kind of work experiences they had during and after participating in the TE program.
- ◆ Similar data for comparable students without TE program experiences

To conduct follow-up evaluations, the TE instructor typically tracks students who have participated in TE—for several years after they have done so. Typical follow-up intervals are 1 year, 3 years, and 5 years after TE. In order for such evaluations to succeed the school must keep careful enrollment and address records both while the students are in school and for at least 5 years after they graduate or leave school.

Typically, because of costs and the work involved, one samples the students who have taken TE rather than surveying all of them. The actual survey method could be:

- ◆ Telephone interview
- ◆ Mail survey
- ◆ In-person interview (at home)

The following represents some typical questions that may be posed in various ways in a follow-up survey.

- ◆ What do TE students think of the program? Did students enjoy TE?
- ◆ How useful was the TE program in developing career and technology awareness?
- ◆ Did TE enhance their understanding of science and technology?
- ◆ What courses were taken after TE?
- ◆ How useful was TE in securing a job?
- ◆ Was TE helpful in identifying and preparing for advanced vocational-technical education?
- ◆ Did TE help them with consumer decisions?

### **National Technology Education Program Standards**

A major national effort has produced a series of standards to facilitate technology education. These standards include:

- ◆ Content standards
- ◆ Assessment standards
- ◆ Program standards
- ◆ Professional development standards

Each of these is designed to improve the teaching and learning process in technology education programs. These standards may be obtained from the International Technology Education Association, 1914 Association Drive, Reston, VA 20191, or from their web site:

<http://www.iteaconnect.org/>

Figure 9-1



### Listing of *STL* Content Standards

#### The Nature of Technology

- Standard 1. Students will develop an understanding of the characteristics and scope of technology.
- Standard 2. Students will develop an understanding of the core concepts of technology.
- Standard 3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

#### Technology and Society

- Standard 4. Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5. Students will develop an understanding of the effects of technology on the environment.
- Standard 6. Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7. Students will develop an understanding of the influence of technology on history.

#### Design

- Standard 8. Students will develop an understanding of the attributes of design.
- Standard 9. Students will develop an understanding of engineering design.
- Standard 10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

#### Abilities for a Technological World

- Standard 11. Students will develop abilities to apply the design process.
- Standard 12. Students will develop abilities to use and maintain technological products and systems.
- Standard 13. Students will develop abilities to assess the impact of products and systems.

#### The Designed World

- Standard 14. Students will develop an understanding of and be able to select and use medical technologies.
- Standard 15. Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.
- Standard 16. Students will develop an understanding of and be able to select and use energy and power technologies.
- Standard 17. Students will develop an understanding of and be able to select and use information and communication technologies.
- Standard 18. Students will develop an understanding of and be able to select and use transportation technologies.
- Standard 19. Students will develop an understanding of and be able to select and use manufacturing technologies.
- Standard 20. Students will develop an understanding of and be able to select and use construction technologies.



## **Chapter 10 – Professional Development**

## **Chapter 10**

### **Professional Development**

#### **1 – Introduction**

Some of the information contained in this chapter is based upon preliminary work by the *Technology for All Americans Project* (TfAAP) staff. Please obtain the current document from the International Technology Education Association (ITEA). Consult their web site at:

<http://www.iteaconnect.org/>

*Advancing Excellence in Technological Literacy: Student Assessment, Professional Development and Program Standards for Technology and Engineering Education Teachers* describes outcome-based criteria: it is intended for use by teachers and by local, district, state/provincial/regional, and federal agencies to insure effective and continuous in-service and pre-service education for teachers of technology. These professional development standards are aligned with *Standards for Technological Literacy: Content for the Study of Technology* (STL): they are engineered to be implemented in conjunction with STL as well as the student assessment and program standards available from ITEA.

Professional Development Standards are best used when curriculum and instruction have incorporated the concepts and principles identified in STL. These standards apply to every teacher who educates students on any aspect of technology, not just teachers who operate primarily within the Technology and Engineering program – for example, these standards are eminently suitable for a social studies teacher who is teaching the social influence of technology or the history of technology. The ultimate goal is for all students, not just the college-bound, to achieve technological literacy. (ITEA, 2003)

#### **2 – Definition of Professional Development**

For the purposes of this document, professional development is a continuous process of life-long learning and growth, beginning in the undergraduate, pre-service years and continuing through the in-service years and beyond.

#### **3 – The Continuous Nature of Professional Development**

Professional development of teachers is an ongoing process in which teachers acquire levels of content knowledge, pedagogical skills, and knowledge of how students learn. This process of continuous development begins at the pre-service level and continues throughout the teaching career. The standards for professional development presented here should be considered outcomes of the professional development continuum.

These standards describe the attributes and skills that teachers should have as a result of engaging in professional development.

Furthermore, teachers of technology go through many career pathways toward the classroom – traditional, university-based programs and a variety of alternative routes. Thus, it is not practical to specify in this document when these target outcomes will be met or achieved. Teachers who have completed a traditional technology teacher training program should have attained these standards at a basic level and should, over time, achieve greater breadth and depth of knowledge and capability.

(ITEA, 2003)



### Listing of AETL Standards

#### Student Assessment Standards

- Standard A-1. Assessment of student learning will be consistent with *Standards for Technological Literacy: Content for the Study of Technology (STL)*.
- Standard A-2. Assessment of student learning will be explicitly matched to the intended purpose.
- Standard A-3. Assessment of student learning will be systematic and derived from research-based assessment principles.
- Standard A-4. Assessment of student learning will reflect practical contexts consistent with the nature of technology.
- Standard A-5. Assessment of student learning will incorporate data collection for accountability, professional development, and program enhancement.

#### Professional Development Standards

- Standard PD-1. Professional development will provide teachers with knowledge, abilities, and understanding consistent with *Standards for Technological Literacy: Content for the Student of Technology (STL)*.
- Standard PD-2. Professional development will provide teachers with educational perspectives on students as learners of technology.
- Standard PD-3. Professional development will prepare teachers to design and evaluate technology curricula and programs.
- Standard PD-4. Professional development will prepare teachers to use instructional strategies that enhance technology teaching, student learning, and student assessment.
- Standard PD-5. Professional development will prepare teachers to design and manage learning environments that promote technological literacy.
- Standard PD-6. Professional development will prepare teachers to be responsible for their own continued growth.
- Standard PD-7. Professional development providers will plan, implement, and evaluate the pre-service and in-service education of teachers.

#### Program Standards

- Standard P-1. Technology program development will be consistent with *Standards for Technological Literacy: Content for the Study of Technology (STL)*.
- Standard P-2. Technology program implementation will facilitate technological literacy for all students.
- Standard P-3. Technology program evaluation will ensure and facilitate technological literacy for all students.
- Standard P-4. Technology program learning environments will facilitate technological literacy for all students.
- Standard P-5. Technology program management will be provided by designated personnel at the school, school district, and state/provincial/regional levels.

## NSDC's Standards for Staff Development

(Revised, 2001) <http://www.nsd.org/>

### Context Standards

Staff development that improves the learning of all students:

- ◆ Organizes adults into learning communities whose goals are aligned with those of the school and district. ([Learning Communities](#))
- ◆ Requires skillful school and district leaders who guide continuous instructional improvement. ([Leadership](#))
- ◆ Requires resources to support adult learning and collaboration. ([Resources](#))

### Process Standards

Staff development that improves the learning of all students:

- ◆ Uses disaggregated student data to determine adult learning priorities, monitor progress, and help sustain continuous improvement. ([Data-Driven](#))
- ◆ Uses multiple sources of information to guide improvement and demonstrate its impact. ([Evaluation](#))
- ◆ Prepares educators to apply research to decision making. ([Research-Based](#))
- ◆ Uses learning strategies appropriate to the intended goal. ([Design](#))
- ◆ Applies knowledge about human learning and change. ([Learning](#))
- ◆ Provides educators with the knowledge and skills to collaborate. ([Collaboration](#))

### Content Standards

Staff development that improves the learning of all students:

- ◆ Prepares educators to understand and appreciate all students, create safe, orderly and supportive learning environments, and hold high expectations for their academic achievement. ([Equity](#))
- ◆ Deepens educators' content knowledge, provides them with research-based instructional strategies to assist students in meeting rigorous academic standards, and prepares them to use various types of classroom assessments appropriately. ([Quality Teaching](#))
- ◆ Provides educators with knowledge and skills to involve families and other stakeholders appropriately. ([Family Involvement](#))

## 5 – Evaluating TE Teacher Effectiveness

Invariably TE instructors will find their own performance being evaluated both formally and informally. TE instructors will typically find themselves evaluated on a wide range of criteria. Usually they include:

- ◆ Instructional effectiveness
- ◆ Motivational ability
- ◆ Facility management
- ◆ Overall program quality
- ◆ The extent to which one contributes to the school

It is recommended that TE instructors deliberately seek formal supervisor and administrator evaluations each year. It is important that such evaluations are carefully done, that they represent an effort commensurate with the importance of instructor evaluation and that they highlight the instructor's strengths and weaknesses. Then, it is vital that all identified weaknesses also be accompanied by a list of recommended actions that could eliminate the weaknesses. As Missouri moves towards more accountability it will be important to keep careful records of such evaluations and to systematically document all progress towards improvement.

As with program evaluation, it is thought that the most effective (in terms of promoting improvement) form of evaluation is self-evaluation. Individual TE instructors might wish to consider how well their teaching meets the criteria set out in the ITEA Professional Development Standards.

Perhaps one of the more effective ways to evaluate one's teaching performance is to have a respected colleague sit in during several of your classes. Thereafter, ask him/her to critique what they observed. It is often useful to have this done by both other TE instructors and also by non-TE teachers. Both can yield unique and valuable perspectives. Instructors may also find it useful to videotape their lesson and then analyze what they see themselves.

## **6 – Performance-Based Evaluation**

Missouri's legislature in 1983 created a law (section 168.128) detailing the requirements for teacher evaluation. The relevant section is quoted in Guidelines for Performance Based Teacher Evaluation in Missouri, a publication available from the Missouri DESE. This document also highlights the background, philosophy and procedures of the recommended teacher evaluation process. Essentially it states that:

- ◆ The principal is responsible for the performance-based teacher evaluation system.
- ◆ Performance-based teacher evaluation systems should include a formative evaluation phase. The formative phase should include both scheduled and unscheduled classroom observations.
- ◆ A pre-observation conference should occur prior to scheduled observations. Formative evaluation includes the classroom observations designed to help teachers improve their performance by providing feedback and suggestions regarding their teaching skills.
- ◆ The summative phase of the evaluation process is a composite of information obtained through the formative observations and may serve as the basis for administrative decision making.
- ◆ A summative evaluation should be completed for a probationary teacher each year. For tenured teachers, a summative evaluation should be completed at least once every three years or as necessary to best serve the instructional process.
- ◆ A post-observation conference should be conducted within a reasonable period of time following each classroom observation. This conference should include a discussion of identified strengths and weaknesses. Job targets for maintaining and improving teacher performance should be completed for a probationary teacher each year.
- ◆ The evaluation system should include an appeal process defined within local school district policy.

Figure 10-1 presents 19 criteria suggested for performance based teacher evaluation systems. The original document then provides useful descriptions for each of these criteria. It is important for the TE instructor to point out to his/her administrator the differences in operating a laboratory-based program from one that is conducted in a typical "normal" classroom.

**Figure 10-1**  
**Suggested Criteria for Performance-Based Teacher Evaluation<sup>1</sup>**

## **I. Instructional Process**

The Teacher

- A. Demonstrates appropriate preparation for classroom instruction.
- B. Implements a variety of effective teaching techniques.
- C. Provides opportunities for individual differences.
- D. Implements instructional objectives effectively.
- E. Demonstrates knowledge of subject matters.
- F. Uses a variety of teaching materials effectively.
- G. Uses instructional time effectively.
- H. Demonstrates ability to motivate students.
- I. Demonstrates ability to communicate effectively with students.
- J. Provides students with specific evaluative feedback.

## **II. Classroom Management**

The Teacher

- A. Organizes classroom environment to promote learning.
- B. Manages student behavior in a constructive manner.

## **III. Interpersonal Relationships**

The Teacher

- A. Demonstrates positive interpersonal relations with students.
- B. Demonstrates positive interpersonal relations with parents/patrons.
- C. Demonstrates positive interpersonal relations with education staff.

## **IV. Professional Responsibilities**

The Teacher

- A. Participates in professional growth activities
- B. Follows the policies and procedures of the school district.
- C. Assumes responsibilities outside of the classroom as they relate to the school.
- D. Demonstrates a sense of professional responsibility.

<sup>1</sup>Guidelines for Performance Based Teacher Evaluation in Missouri. 1984.

## Bibliography

\_\_\_\_\_. (1991). *Guidelines for Performance Based Evaluation: Teachers, counselors, librarians.* (1984 Reprint). Jefferson City, MO: Missouri: Missouri Department of Elementary and Secondary Education.

ITEA (2000). *Standards for Technological Literacy: Content for the Study of Technology.* Reston, VA.

ITEA (2003). *Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards.* Reston, VA.

NSDC (2001). *Standards for Professional Development.* Dallas, TX.



## **Chapter 11 – Resources**

## Chapter 11 Resources

### 1 – Web – based Resources

The electronic age has given our profession an avalanche of information almost at our fingertips. It is impossible to list in a single document all the resources available. In addition, resources today may or may not be reliable. Therefore, it is important to have a means of continual oversight of the reliability and timeliness of information. For this reason, this guide will provide only a few critical links to web sites that can “jump-start” a search for information. The first link will take you to the Career and Technology and Engineering web site at Central Missouri State University - where you will find a “Resource” link that will give you up-to-date information. This web site will be maintained for currency and reliability as well as relevance to the profession. Teachers who use the site are welcome to pass on information they feel is important for the profession and give feedback on current listed sites.



Career and Technology Education Resources: <http://www.ucmo.edu/cte/>

Technology and Engineering Resources: <http://www.ucmo.edu/cte/programs/teched/index.cfm>



Missouri Center for Career Education: <http://missouricareereducation.org/>



Career Education: <http://dese.mo.gov/divcareered/>

Technology and Engineering Education: [http://dese.mo.gov/divcareered/tech\\_ed\\_index.htm](http://dese.mo.gov/divcareered/tech_ed_index.htm)



International Technology Education Association: <http://www.iteaconnect.org/>



Missouri Association for Career & Technical Education: <http://www.mo-acte.org/>



Association for Career & Technical Education, <http://www.acteonline.org/>



Technology Education Association of Missouri, <http://www.moteam.org/>





## **Glossary**

## Glossary

**Accountability** – Being held answerable or responsible for. In education, it is being held responsible for what is taught and what is learned.

**Affective Domain** – that area of learning which emphasizes a feeling tone, an emotion or a degree of acceptance or rejection.

**Americans with Disabilities (ADA)** - Prohibits discrimination in employment and other situations against persons with disabilities.

**Area Career Technical Center (ACTC)** - A public educational institution that has been designated by the State Board of Education. An area career technical center may be: 1) a specialized high school; 2) a department of a high school; 3) a department or division of a junior/community college, used exclusively for vocational education. Area schools provide career and technical education on a regional basis for high school students and adults.

**Articulation** –Planned sequence of curriculum and/or course offerings from kindergarten to twelfth grades.

**Assessment** – The systematic process of collecting information on students' learning, understanding, and capability then using that information to reform instruction and enhance learning.

**Alternative Assessments** – This type of assessment, synonymous with authentic- and performance-based assessment, requires students to actively accomplish significant tasks using the knowledge and skills learned. Examples of types of assessment are demonstrations, projects, written or oral reports, student interviews, portfolios, and self-assessments that are graded or evaluated.

**Association for Career and Technical Education** – The largest national education associated dedicated to the advancement of education that prepares youth and adults for careers (formerly the American Vocational Association (AVA)).

**Authentic Assessment** – A method that directly examines student performance on tasks which are directly related “real” life experiences and applications.

**Basic Skills** – A teaching position that provides individual or small group instruction in mathematics, reading and writing skills essential for successful completion of a vocational training program. The instruction is provided in cooperation with the vocational teacher and concurrently with enrollment in a vocational program.

**Benchmarks** – Objectives that articulate the knowledge and abilities that will enable the student to meet the respective standard.

**Brainstorming** – A group problem-solving technique that involves the spontaneous contribution of ideas from all members of the group.

**Career and Technical Education** – formal and informal education that deals with preparing students for specific careers in vocational and/or technical occupations

**Career and Technical Education Resources (CATER)** – This is a library exclusively for Missouri educators designed to supplement and enhance career and technical education curriculum (formerly MRCCTE). Books, guides, games, directories, games, kits and videos related to health, business, agriculture, technology, family and consumer sciences and marketing education are available free-for-loan.

**Career and Technical Student Organization** – Organizations (such as FFA, FBLA, etc.) for students and educators involved in specific areas of career and technical education (formerly known as career and technical student organizations [CTSO]).

**Carl D. Perkins Vocational and Applied Technology Education Act** – federal law providing federal support for career and technical education primarily targeting programs for high school students and post-secondary students attending community and technical colleges

**Cognitive Domain** – the area of learning which deals with the recall or recognition of knowledge and the development of intellectual abilities or skills.

**Collaboration** – to work jointly with others thereby enabling goals to be accomplished more effectively and comprehensively than by individual efforts.

**Community Partnerships** – Community partnerships are often established by a middle school to encourage interaction between the students and teachers and the community as a whole. Through partnerships, schools are able to demonstrate how business and industry contribute to the community. Students learn about cooperation, are encouraged to participate in community activities and events, and discover the many resources available to them, such as libraries, museums, government agencies, and civic organizations.

**Comprehensive School Improvement Plan (CSIP)** – A plan developed by local schools to incorporate all major concerns identified by their MSIP review and confirmed by the Department’s School Improvement Committee.

**Computer-Assisted Drafting (CAD)** – The use of a computer as a drafting aid in the field of drafting and design. Also referred to as computer-aided drafting.

**Concept** – A broad category of information that has distinguishing features that are commonly held.

**Concept map** – A map depicting the hierarchical order of key concept words and propositions. The map is designed with a key word or question at the top, and then related words, phrases, and ideas are linked with arrows and lines depicting relationships and connections. The linkages also have phrases that show the relationship.

**Constraint** – Side effect or limit within the design process.

**Cooperative Learning** – This type of learning is based on the notion that students can learn from each other by coordinating efforts in a format that promotes the exchange of dialogue and ideas. Each member of the small learning group has a role or responsibility to share and contribute to the other members’ and the groups’ progress.

**Core Services for the Workforce Investment Act** – Basic/initial services that are available at any One-Stop Career Center. These services are available to anyone. These services include: 1) determination of whether the individual is eligible to receive additional assistance under the Workforce Investment Act; 2) outreach, intake and orientation to the information and other services available through the one-stop delivery system; 3) initial assessment of skills, aptitudes, abilities, and supportive service needs; 4) job search and placement assistance and where appropriate, career counseling; 5) provision of local employment information; 6) performance information and programs cost on eligible providers of training services; 7) information regarding how the local area is performing in the local performance measures; 8) information regarding the availability of supportive services; 9) information regarding filing claims for unemployment compensation; 10) eligibility for welfare programs and financial aid assistance; and 11) follow-up services.

**Core Competencies** - A set of skills, knowledge, and attitudes necessary for success in a given area of study. Specific behaviors which may be knowledge, skill, or attitudinal in nature have been identified as components of an occupation.

**Core Concepts** – A set of ideas that make up the basis for the study of a particular subject or area of study.

**Core Data** - The collection, compilation and dissemination of descriptive statistics about Missouri public schools, including publication and distribution of the [Missouri School Directory](#) , the Annual Report of the Public Schools of Missouri and the [School District Profiles](#) . Educational statistics are provided to the [Missouri State Teachers Association](#) , [National Education Association](#) , [US Office of Education](#) , and other organizations that seek information about Missouri public schools. The section maintains databases of [Missouri public school information](#) and performs ad hoc queries to provide historical data and specialized reports in response to individual requests.

**Corporate Partnerships** – A school or Technology and Engineering department forms a partnership with a business or industry in the community in order to enhance the study of particular technologies or processes.

**Course Code** – A code number issued by the Missouri Department of Elementary and Secondary Education to identify courses through the core data system.

**Course/Courses of Study** – A series of lessons, activities, projects, or lectures that last a specified period of time and are designed around a specified subject.

**Course Objectives** – Description of what a student will know and be able to do upon successful completion of the course.

**Creative-thinking Skills** – the ability to gain, analyze and evaluate information come to a conclusion by using logic and reasoning skills. The four main categories are fluency, flexibility, originality, and elaboration.

**Creativity** – The ability to look at the same thing as everyone else but to see it differently.

**Criterion** – The desired element or feature of a product or system.

**Criterion-referenced** – an assessment of student performance in terms of some criterion of specified standard of performance. This is in direct contrast to the norm-referenced approach where students are assessed in terms of how they compare with other students. (Erickson & Wentling, 1988).

**CSTL** – Companion Standards for Technology Literacy: Student Assessment, Professional Development, and Program (ITEA, 2002).

**Curriculum** – The sum of the learning activities and experiences that a student has under the auspices or direction of the school.

**Customized Training (CT)** – Training that is designed to meet the special requirements of an employer who is committed to employ an individual upon successful completion of training, for which the employer will receive not less than 50 percent of the cost of the training.

**Delta Pi Epsilon (DPE)** – A national graduate honorary society for professionals who support and promote scholarship, leadership and cooperation towards the advancement of education for and about business.

**Department of Elementary and Secondary Education (DESE)** - The state agency for elementary and secondary education comprised of a team of dedicated individuals working for the continuous improvement of education and services for all citizens.

**Department of Labor (DOL)** – This federal agency fosters and promotes the welfare of the job seekers, wage earners and retirees of the United States by improving their working conditions, advancing their opportunities for profitable employment, protecting their retirement and health care benefits, helping employers find workers, strengthening free collective bargaining, and tracking changes in employment, prices and other national economic measurements.

**Design Briefs** – A written plan that identifies the problem to be solved. It is used to help students think of all aspects of the problem before starting to work on improving and/or developing a way of doing something. The design brief describes the problem, identifies the criteria, and lists the constraints students will face in creating a solution.

**Design Process** – A problem-solving strategy, with criteria and constraints, used to develop many possible solutions to solve a problem or satisfy human needs and wants. The design process is a general developmental method that is iterative (not linear).

**Dictionary of Occupational Titles (DOT)**– The Department of Labor publication that contains a large number of very specific detailed and precise descriptions of jobs in the United States.

**Division of Workforce Development (DWD)** – A state government office that supports a system that will provide employers with a skilled workforce and provides job seekers with access to jobs with increased earning potential.

**Division of Youth Services (DYS)** – Youth judged to be delinquent and in need of rehabilitation and education are committed to the Division of Youth Services by the state’s juvenile circuit courts until approved for return to the community under supervision or are discharged. The Division provides an array of services including institutional care, community-based services, non-residential services and after-care supervision. The Division of Youth Services is part of the Department of Social Services.

**Emotionally Disturbed** – A type of disorder where observed behaviors deviate from the average or typical. Students with emotional or behavioral disabilities exhibit undesirable actions or feelings over along period of time which adversely affects performance. Symptoms include an inability to get along with their peers as well as hyperactivity. This is also known as behavior disorder.

**Entrepreneurship** – the ability to organize, manage, and assume risks of a business or enterprise.

**Formative Assessment** – Assessments that serve the role of providing feedback to teachers to help modify and improve teaching and learning.

**Gaming** – Gaming refers to the less realistic activities in which students are presented with a situation involving choices, risks, and pay-offs. Much is learned as students enjoy the challenge or the chance to play to win.

**General Education** – Courses that include core subjects such as basic reading, writing, science, and math skills.

**Goals** – Broad aims or purposes of a total educational curriculum or the broad outcomes expected within a specific program.

**High Schools That Work (HSTW)**– A model of high school reform developed by the Southern Regional Education Board (SREB) that integrates academic and vocational education, promotes staff development and raises expectations for and achievement of students.

**Impact of Technology** – The results of technological change. These outcomes may affect our society in economic, cultural, social, political, environmental, or a combination of many of these ways. The impact of technology can be observed in history, identified in the present day, and predicted for the future.

**Industrial Arts** – a curricular field that pertains to the study of tools, crafts and skills of industry

**Industrial Technology** – a curricular field that pertains to the study of industrial-based technological systems

**Information Society** – economy that emphasizes the output of information as a product

**Instructional Materials Laboratory (IML)** – The Instructional Materials Laboratory (IML), located within the College of Education at the University of Missouri-Columbia, is a national leader in curriculum development and publications specializing in career and technical education.

**Internal Alignment** – The process of aligning target/enabling objectives through lesson/guided practice to assessment where by each match a common cognitive, affective, or psychomotor domain.

**International Technology Education Association (ITEA)** – an international professional teacher organization promoting the teaching of technological literacy on the K – 12 grade levels

**Internships** – Work experience in the private sector. A short-term pre-vocational service designed to instill work habits and work ethics, or to allow the sampling of jobs to determine if an individual has the aptitude and interests necessary for training and/or placement.

**Invention** – The creation of a completely new idea, device, or different way of doing something.

**Innovation** – The improvement of an existing idea, device, or way of doing something in a creative or different way.

**Iterative** – involving repetition

**Leadership** – This ability enables people to influence others. Leading in a group involves planning, organizing, communication, managing, and cooperating.

**Learning Disability** – A disorder in one or more of the basic psychological processes involved in the understanding or use of spoken or written language, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations. Causes may be perceptual handicaps, brain injury, brain dysfunction, dyslexia, and developmental aphasia.

**Limited English Proficiency (LEP)** – Any person who has limited ability in speaking, reading, writing or understanding the English language; and whose native language is a language other than English; or who lives in a family or community environment where a language other than English is the primary language.

**Local Education Agency (LEA)**– The term used for public elementary and secondary school districts and other public schools such as the state schools for the deaf and the blind.

**Mental Disorder** – Disorders marked by social deviance, personality disturbances, and emotional turmoil.

**Missouri Association for Career and Technical Education (MoACTE)**– An association promoting the development of vocational-technical education within the state of Missouri continually emphasizing continued support of vocational-technical education at the secondary, postsecondary and adult levels, while fostering partnerships with business and industry in the training and re-training of the Missouri workforce.

**Missouri Comprehensive Guidance Program** – The Missouri Comprehensive Guidance Program is designed to serve all students in grades K-12 and help insure equal opportunity for all students to participate fully in the educational process integrating academics, career and personal/social development.

**Missouri Council for Career and Technical Administrators (MCCTA)**– A professional association of administrators, supervisors, state education staff members and department heads of vocational, technical practical arts education programs at the secondary, postsecondary, adult and collegiate levels that promotes career and technical education in the state.

**Missouri Economic Research and Information Center (MERIC)**– A multi-agency entity that is responsible for Missouri’s occupational and labor market information system. MERIC distributes information for career development and human resource planning and coordinates data produced by member agencies.

**Missouri School Improvement Program (MSIP)** – The Missouri School Improvement Program reviews and accredits the school districts in the state within a five-year review cycle. School district reviews cover the areas of resource, process and performance. The process of accrediting school districts is mandated by state law.

**Missouri Trade & Technical Association (MTTA)** – An organization to support and assist trade and technical instructors in both secondary and postsecondary areas. This support consists of technical upgrades and workshops, as well as academic training.

**Missouri Vocational Special Needs Association (MVSNA)** – An organization for persons interested in service to Missouri’s special needs population that includes students in Missouri who are disadvantaged and students with disabilities. This group could consist of counselors, basic skills instructors, vocational resource educators, supplemental/vocational preparation instructors and evaluators

**Modeling Lab** – This type of learning environment contains table top machines and a variety of tools and materials to promote the exploration, investigation and creation of a variety of products and systems. The modeling lab provides for individual or group learning activities. Support materials may be used, such as computers, multi-media, and textbooks.

**Modular Lab** – This type of learning environment uses modules to create learning centers throughout the Technology and Engineering room. The module contains instructional equipment that delivers the content or lesson, generally to show students. The students learn and work through the use of a booklet or a computer. Support material is provided through watching video, reading textbooks, and building a project using appropriate tools, machines, and materials as identified in each module.

**Modeling and Modular Lab (Combination)** – This type of learning environment combines the modeling and modular labs into one laboratory-classroom. Students work in a variety of settings from prescribed modules in pairs to group projects developed by the student using a combination of modules and equipment. Students are able to move from identified learning goals to free exploration and development of products and systems. Opportunities for learning about inventions and innovations provide open-ended problem-solving experiences.

**National Tech Prep Network (NTPN)** – An organization for educators and employers involved in the advancement of Tech Prep and related education reform initiatives.

**Objectives** – sometimes referred to as behavioral, performance, instructional, or target objectives. Objectives usually represent smaller and more limited segments of larger goals.

**Occupational Outlook Handbook** – This Department of Labor publication describes approximately 250 occupations in detail covering 104 million jobs or about 85 percent of all jobs in the nation. (OCR)– A federal office that oversees regulation and implementation of Title IX of the Education Amendments of 1964; Title VI of the Civil Rights Act of 1964; Section 504 of the Rehabilitation Act of 1973; and Title II of the Americans with Disabilities Act of 1990. The regional office for Missouri is located in Kansas City at 816.880.4200. Office for Civil RightsOn-the-Job Training (OJT)– Training by an employer that is provided to a paid participant while engaged in productive work in a job that provides knowledge or skills essential to the full and adequate performance of the job; provides reimbursement to the employer of up to 50% of the wage rate of the participant, for the extraordinary costs of providing the training and additional supervision related the training; and is limited in duration as appropriate to the occupation for which the participant is being trained, the prior work experience of the participant, and the service strategy of the participant, as appropriate.

**Oral Presentation** – Takes place at the completion of an individual or group project. This report may include the use of visuals, such as illustrations, photographs, computer-generated images, models, posters, flip charts, or slides.

**Performance Assessment (test)** – assessment tools and/or procedures in which students are evaluated while they are performing certain selected task.

**Post-industrial Society** – emphasizes of economy away from heavy industrial production

**Portfolio** – A systematic and organized collection of a student’s work that includes results of research, successful and less successful ideas, notes on procedures, and data collected. The design portfolio or design log may also be used to demonstrate the cumulative learning process of a student over a unit of study, grading period, or entire course of study.

**Practical Arts** – those curriculum areas that include Technology and Engineering, business education, agricultural education, family consumer sciences, and all other vocational education areas.

**Problem Solving** – The logical process of using prior knowledge, asking questions, testing and trying ideas in order to solve a problem, to meet a need or want, or to improve a process or product.

**Psychomotor Domain** – that area of learning that emphasizes some muscular or motor control, some manipulation of material or objects, or some act which requires a neuromuscular coordination.

**School-to-Work (STW)** – A systemic approach to combining work-based learning, class-based learning and connecting activities to provide students with the opportunity to begin the process of making educated career decisions while in school.

**Science, Technology, and Society (STS)** – This technique allows students to take an interdisciplinary approach when examining the concepts and processes of science and technology and relating the effects of each on society. This study helps lead to an informed citizenry capable of making responsible and social decisions.

**Scoring Guide** – Scoring Guides are a means to score the work of students that show detailed criteria for each level of accomplishment. It should be developed with student input so that they may develop an understanding of value-added learning. A rubric enables the teacher and student to know what is to be addressed and how it will be weighted.

**Section 504 of the Rehabilitation Act of 1973** – Bars discrimination based on disability under any program or activity receiving funds from the U. S. Department of Education.

**Service Learning** – Federally funded program experiential learning through the integration of classroom curriculum and structured community service activities; also name given to the methodology of such practice.

**Sharing** – Students give short talks about what they are learning about or doing in class. They may offer advice to other students during formal seminars or as a part of teamwork and cooperative learning.

**Show-Me Standard** – Missouri educational content and performance standards established by Department of Elementary and Secondary Education and required by Missouri legislation

**Simulation** – This teaching strategy engages students in roles that are similar to real life. The students will learn how to apply the concepts learned in class, such as expressing their views and making decisions, to these real-life situations.

**Smoke Stack Industry** – emphases of economy on heavy industrial product output

**Special Populations** – Individuals with disabilities, economically disadvantaged individuals, individuals preparing for non-traditional employment, single parents, displaced homemakers, others with barriers, including individuals with limited English proficiency.

**Standards-Based Assessment** – Student products and performances are assessed by using measurable objectives that relate to the overall desired content to be learned as identified in the standards.

**Standards for Technological Literacy: Content for the Study of Technology** – a set of twenty standards for technological literacy developed under the direction of Technology For All Americans Project (TFAAP), commissioned by the International Technology Education Association.

**Summative Assessment** – Assessments that serve the role of measuring the degree of learning upon the completion of a set of learning activities.

**TAMS – Technology Activity Modules**

**Teamwork** – This process helps students work and learn together. Small groups or teams encourage students to share knowledge and skills while completing both short and long assignments. This is similar to the professional world, such as a project team consisting of engineers who bring different expertise to the group.

**Technological Assessment** – is a process of evaluating new technological items to predict the good and bad effects that may result. This process of thinking will lead to the identification of second, third, and fourth effects that may affect society more deeply than the primary effects. Using technological assessment leads to socially responsible decision-making.

**Technological Capability** – the level at which a business or industry can use technology for their benefit

**Technological Literacy** – the ability to use, manage, assess and understand technology

**Technology** – how people modify the natural world to suit their own purposes

**Technology Education** – The school subject that teaches about the processes used to design, create and maintain the human-built world

***Technology for All Americans Project*** – an organization commissioned by the International Technology Education Association (ITEA) to produce national standards for technological literacy

**Technology Student Association (TSA)** – The national organization for Technology and Engineering students, educators, parents and business leaders who are interested in learning how technology can be put to best use in discovering technological solutions to today’s and tomorrow’s challenges.

**Tech-Prep** – Short for Technical Preparation, a program that employs creative linkages between high schools and community and technical colleges.

**Title IX of the Educational Amendments of 1972** (Title IX)– Bars discrimination based on gender under any program or activity receiving funds from the U. S. Department of Education.

**Title VI of the Civil Rights Act of 1964** (Title VI)– Bars discrimination based on race or color under any program or activity receiving funds from the U. S. Department of Education.

**Trade-offs** – consequences of decisions made concerning the development of and/or use of a particular technology or technologies

**United States Department of Education (USDE)**– The federal education agency. Its responsibilities include higher education and student financial aid programs, as well as programs associated with elementary and secondary education.

**Vocational Instructional Management System (VIMS)** – A systematic approach to defining and measuring the knowledge, skills and attitudes students need to acquire in specific occupational areas.

**Vocational Education** – Now known as Career Education – formal and informal education that deals with preparing students for specific careers and technical skills.





## **Appendices**

### Appendix A – ITEA STL Content Standards List



#### Listing of STL Content Standards

##### The Nature of Technology

- Standard 1. Students will develop an understanding of the characteristics and scope of technology.
- Standard 2. Students will develop an understanding of the core concepts of technology.
- Standard 3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

##### Technology and Society

- Standard 4. Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5. Students will develop an understanding of the effects of technology on the environment.
- Standard 6. Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7. Students will develop an understanding of the influence of technology on history.

##### Design

- Standard 8. Students will develop an understanding of the attributes of design.
- Standard 9. Students will develop an understanding of engineering design.
- Standard 10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

##### Abilities for a Technological World

- Standard 11. Students will develop abilities to apply the design process.
- Standard 12. Students will develop abilities to use and maintain technological products and systems.
- Standard 13. Students will develop abilities to assess the impact of products and systems.

##### The Designed World

- Standard 14. Students will develop an understanding of and be able to select and use medical technologies.
- Standard 15. Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.
- Standard 16. Students will develop an understanding of and be able to select and use energy and power technologies.
- Standard 17. Students will develop an understanding of and be able to select and use information and communication technologies.
- Standard 18. Students will develop an understanding of and be able to select and use transportation technologies.
- Standard 19. Students will develop an understanding of and be able to select and use manufacturing technologies.
- Standard 20. Students will develop an understanding of and be able to select and use construction technologies.



### Listing of AETL Standards

#### Student Assessment Standards

- Standard A-1. Assessment of student learning will be consistent with *Standards for Technological Literacy: Content for the Study of Technology (STL)*.
- Standard A-2. Assessment of student learning will be explicitly matched to the intended purpose.
- Standard A-3. Assessment of student learning will be systematic and derived from research-based assessment principles.
- Standard A-4. Assessment of student learning will reflect practical contexts consistent with the nature of technology.
- Standard A-5. Assessment of student learning will incorporate data collection for accountability, professional development, and program enhancement.

#### Professional Development Standards

- Standard PD-1. Professional development will provide teachers with knowledge, abilities, and understanding consistent with *Standards for Technological Literacy: Content for the Student of Technology (STL)*.
- Standard PD-2. Professional development will provide teachers with educational perspectives on students as learners of technology.
- Standard PD-3. Professional development will prepare teachers to design and evaluate technology curricula and programs.
- Standard PD-4. Professional development will prepare teachers to use instructional strategies that enhance technology teaching, student learning, and student assessment.
- Standard PD-5. Professional development will prepare teachers to design and manage learning environments that promote technological literacy.
- Standard PD-6. Professional development will prepare teachers to be responsible for their own continued growth.
- Standard PD-7. Professional development providers will plan, implement, and evaluate the pre-service and in-service education of teachers.

#### Program Standards

- Standard P-1. Technology program development will be consistent with *Standards for Technological Literacy: Content for the Study of Technology (STL)*.
- Standard P-2. Technology program implementation will facilitate technological literacy for all students.
- Standard P-3. Technology program evaluation will ensure and facilitate technological literacy for all students.
- Standard P-4. Technology program learning environments will facilitate technological literacy for all students.
- Standard P-5. Technology program management will be provided by designated personnel at the school, school district, and state/provincial/regional levels.

## **Appendix C – Missouri Show—Me Standards**

### **The Missouri Show-Me Performance Standards**

All Missourians are eager to ensure that graduates of Missouri’s public schools have the knowledge, skills and competencies essential to leading productive, fulfilling and successful lives as they continue their education, enter the workforce and assume their civic responsibilities. Schools need to establish high expectations that will challenge all students to reach their maximum potential. To that end, the [Outstanding Schools Act of 1993](#) called together master teachers, parents and policy-makers from around the state to create Missouri academic standards. These proposed standards are the work of that group. The standards are built around the belief that the success of Missouri’s students depends on both a solid foundation of knowledge and skills and the ability of students to apply their knowledge and skills to the kinds of problems and decisions they will likely encounter after they graduate.

The academic standards incorporate and strongly promote the understanding that active, hands-on learning will benefit students of all ages. By integrating and applying basic knowledge and skills in practical and challenging ways across all disciplines, students experience learning that is more engaging and motivating. Such learning stays in the mind long after the tests are over and acts as a springboard to success beyond the classroom.

These standards for students are not a curriculum. Rather, the standards serve as a blueprint from which local school districts may write challenging curriculum to help all students achieve their maximum potential. Missouri law assures local control of education. Each school district will determine how its curriculum will be structured and the best methods to implement that curriculum in the classroom.

The academic standards are grouped around four goals:

[Goal 1](#) -- Students in Missouri public schools will acquire the knowledge and skills to gather, analyze and apply information and ideas.

[Goal 2](#) -- Students in Missouri public schools will acquire the knowledge and skills to communicate effectively within and beyond the classroom.

[Goal 3](#) -- Students in Missouri public schools will acquire the knowledge and skills to recognize and solve problems.

[Goal 4](#) -- Students in Missouri public schools will acquire the knowledge and skills to make decisions and act as responsible members of society.

### **The Missouri Show-Me Knowledge Standards**

Missouri students must build a solid foundation of factual knowledge and basic skills in the traditional content areas. The statements listed here represent such a foundation in [reading, writing, mathematics, world and American history, forms of government, geography, science, health/physical education](#) and the [fine arts](#). This foundation of knowledge and skills would also be incorporated into courses in vocational education and practical arts. Students would acquire this knowledge base at various grade levels and through various courses of study. Each grade level and each course sequence would build on the knowledge base acquired at a previous grade level or in a previous course.

These concepts and areas of study are indeed significant to success in school and in the workplace. However, they are neither inclusive nor are they likely to remain the same over the years. We live in an age in which “knowledge” grows at an ever-increasing rate, and our expectations for students must keep up with that expanding knowledge base.

Combining what students must know and what they must be able to do may require teachers and districts to adapt their curriculum. To assist districts in this effort, teachers from across the state are developing curriculum frameworks in each of the content areas. These frameworks show how others might balance concepts and abilities for students at the elementary, middle and secondary levels. These models, however, are

only resources. Missouri law assures local control of education. Each district has the authority to determine the content of its curriculum, how it will be organized and how it will be presented.

**In Communication Arts**, students in Missouri public schools will acquire a solid foundation which includes knowledge of and proficiency in:

- ◆ speaking and writing standard English (including grammar, usage, punctuation, spelling, capitalization)
- ◆ reading and evaluating fiction, poetry and drama
- ◆ reading and evaluating nonfiction works and material (such as biographies, newspapers, technical manuals)
- ◆ writing formally (such as reports, narratives, essays) and informally (such as outlines, notes)
- ◆ comprehending and evaluating the content and artistic aspects of oral and visual presentations (such as story-telling, debates, lectures, multi-media productions)
- ◆ participating in formal and informal presentations and discussions of issues and ideas
- ◆ identifying and evaluating relationships between language and culture

**In Fine Arts**, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

- ◆ process and techniques for the production, exhibition or performance of one or more of the visual or performed arts
- ◆ the principles and elements of different art forms
- ◆ the vocabulary to explain perceptions about and evaluations of works in dance, music, theater and visual arts
- ◆ interrelationships of visual and performing arts and the relationships of the arts to other disciplines
- ◆ visual and performing arts in historical and cultural contexts

**In Health/Physical Education**, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

- ◆ structures of, functions of, and relationships among human body systems
- ◆ principles and practices of physical and mental health (such as personal health habits, nutrition, stress management)
- ◆ diseases and methods for prevention, treatment and control
- ◆ principles of movement and physical fitness
- ◆ methods used to assess health, reduce risk factors, and avoid high risk behaviors (such as violence, tobacco, alcohol and other drug use)
- ◆ consumer health issues (such as the effects of mass media and technologies on safety and health)
- ◆ responses to emergency situations

**In Mathematics**, students in Missouri public schools will acquire a solid foundation which includes knowledge of

- ◆ addition, subtraction, multiplication and division; other number sense, including numeration and estimation; and the application of these operations and concepts in the workplace and other situations
- ◆ geometric and spatial sense involving measurement (including length, area, volume), trigonometry, and similarity and transformations of shapes
- ◆ data analysis, probability and statistics
- ◆ patterns and relationships within and among functions and algebraic, geometric and trigonomet-

ric concepts

- ◆ mathematical systems (including real numbers, whole numbers, integers, fractions), geometry, and number theory (including primes, factors, multiples)
- ◆ discrete mathematics (such as graph theory, counting techniques, matrices)

**In Science**, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

- ◆ properties and principles of matter and energy
- ◆ properties and principles of force and motion
- ◆ characteristics and interactions of living organisms
- ◆ changes in ecosystems and interactions of organisms with their environments
- ◆ processes (such as plate movement, water cycle, air flow) and interactions of earth's biosphere, atmosphere, lithosphere and hydrosphere
- ◆ composition and structure of the universe and the motions of the objects within it
- ◆ processes of scientific inquiry (such as formulating and testing hypotheses)
- ◆ impact of science, technology and human activity on resources and the environment

**In Social Studies**, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

- ◆ principles expressed in the documents shaping constitutional democracy in the United States
- ◆ continuity and change in the history of Missouri, the United States and the world
- ◆ principles and processes of governance systems
- ◆ economic concepts (including productivity and the market system) and principles (including the laws of supply and demand)
- ◆ the major elements of geographical study and analysis (such as location, place, movement, regions) and their relationships to changes in society and environment
- ◆ relationships of the individual and groups to institutions and cultural traditions
- ◆ the use of tools of social science inquiry (such as surveys, statistics, maps, documents)



**STEM Cluster**  
**Engineering & Technology Pathway**



Elementary	6 <sup>th</sup> Grade	7 <sup>th</sup> Grade	8 <sup>th</sup> Grade
Integrated Lessons (KITS)*	Exploring Technology*	Invention & Innovation*	Technological Systems*
<b>High School</b>	<b>10<sup>th</sup> Grade</b>	<b>11<sup>th</sup> Grade</b>	<b>12<sup>th</sup> Grade</b>
English I	English II	English III	English IV
Algebra I or Geometry	Geometry or Algebra II	Algebra II, Pre-Calculus, or Trigonometry	Trigonometry or Calculus
Physical Science or Biology I	Biology I or Chemistry I	Chemistry or Physics	AP Biology, AP Chemistry, or AP Physics
Geography/State History	World History	American History	Economics/Government
Required Courses/Electives PE, Health, Art, Foreign Language, or Computer Technology	Required Courses/Electives PE, Health, Art, Foreign Language, or Computer Technology	Advanced Technology/Engineering Electives Choose one: Advanced Design Applications*	Technology Capstone Engineering Design*
Career Electives Foundations of Technology* (Transition Course)	Career Electives Choose one: Technological Design* Technological Issues* Impacts of Technology*		
<b>Post-Secondary</b>	<b>Technology Center</b>	<b>Community College</b>	<b>College/University</b>
<input type="checkbox"/> Automated Manufacturing Technology <input type="checkbox"/> Drafting and CAD <input type="checkbox"/> Electronics <input type="checkbox"/> Industrial Maintenance <input type="checkbox"/> Manufacturing Engineering Technology <input type="checkbox"/> Precision Machining	<input type="checkbox"/> Design Engineering Technology <input type="checkbox"/> Pre-Engineering <input type="checkbox"/> Industrial Drafting <input type="checkbox"/> Biology <input type="checkbox"/> Chemistry <input type="checkbox"/> Physics <input type="checkbox"/> Mathematics	<input type="checkbox"/> Mechanical Engineering <input type="checkbox"/> Civil Engineering <input type="checkbox"/> Mathematics <input type="checkbox"/> Biology <input type="checkbox"/> Biochemistry <input type="checkbox"/> Chemistry <input type="checkbox"/> Physics <input type="checkbox"/> Management Science and Systems Analysis	
<b>Career Options</b>	<b>Work-based Learning Options</b>	<b>Short-term Training Options</b>	
Job Shadowing: Internship/Mentorship: On-The-Job Training:	<input type="checkbox"/> Safety Training <input type="checkbox"/> Visual Basic 6 <input type="checkbox"/> Internet & Network Security	<input type="checkbox"/> Wireless Technology <input type="checkbox"/> VB Net <input type="checkbox"/> AutoCAD	

\*These courses are part of the Engineering byDesign™ Program curriculum. More information is available at [www.teachstem.org](http://www.teachstem.org).



**STEM Cluster  
Science & Mathematics Pathway**



Elementary	6 <sup>th</sup> Grade	7 <sup>th</sup> Grade	8 <sup>th</sup> Grade
Integrated Lessons (KITS)*	Exploring Technology*	Invention & Innovation*	Technological Systems* Algebra I
Middle School	10 <sup>th</sup> Grade	11 <sup>th</sup> Grade	12 <sup>th</sup> Grade
English I	English II	English III	English IV
Geometry	Algebra II	Pre-Calculus, or Trigonometry	Trigonometry or Calculus
AP Biology	AP Chemistry	AP Physics	Engineering Science
Geography/State History	World History	American History	Economics/Government
Required Courses/Electives PE, Health, Art, Foreign Language, or Language, or Computer Technology	Required Courses/Electives PE, Health, Art, Foreign Language, or Computer Technology	Advanced Technology/Engineering Electives Advanced Technological Applications*	Technology Capstone Engineering Design*
Career/Electives Foundations of Technology* (Transition Course)	Career/Electives Advanced Design Applications*		
High School	Technology Center	Community College	College/University
	<input type="checkbox"/> Automated Manufacturing Technology <input type="checkbox"/> Drafting and CAD <input type="checkbox"/> Electronics <input type="checkbox"/> Industrial Maintenance <input type="checkbox"/> Manufacturing Engineering Technology <input type="checkbox"/> Precision Machining	<input type="checkbox"/> Design Engineering Technology <input type="checkbox"/> Pre-Engineering <input type="checkbox"/> Industrial Drafting <input type="checkbox"/> Biology <input type="checkbox"/> Chemistry <input type="checkbox"/> Physics <input type="checkbox"/> Mathematics	<input type="checkbox"/> Mechanical Engineering <input type="checkbox"/> Civil Engineering <input type="checkbox"/> Mathematics <input type="checkbox"/> Biology <input type="checkbox"/> Biochemistry <input type="checkbox"/> Chemistry <input type="checkbox"/> Physics <input type="checkbox"/> Management Science and Systems Analysis
Post-Secondary	Work-based Learning Options	Short-Term Training Options	Short-Term Training Options
Career Placement Options	Job Shadowing; Internship/Mentorship; Or- The-Job Training.	<input type="checkbox"/> Safety Training <input type="checkbox"/> Visual Basic 6 <input type="checkbox"/> Internet & Network Security	<input type="checkbox"/> Wireless Technology <input type="checkbox"/> VB Net <input type="checkbox"/> AutoCAD

\*These courses are part of the Engineering byDesign™ Program curriculum. More information is available at [www.teac.hstsem.org](http://www.teac.hstsem.org).

# Appendix E – Responsibility Matrix for STL Standards and Benchmarks

Program Responsibility Matrix: Technology/Science/Mathematics



**KEY**  
 4 = Benchmark must be covered in detail, lessons and assessments cover this content  
 3 = Benchmark is covered, but topics and lessons do not center on them  
 2 = Topics and lessons refer to previous knowledge and integrate content covered  
 1 = Topics and lessons refer to previous knowledge

## The Nature of Technology

### STL-1 Understanding the characteristics and scope of technology

	8	12	12	16	7	10	13	10	10	9	10	11
<b>A</b>	4											
<b>B</b>	4											
<b>C</b>	4											
<b>D</b>	4											
<b>E</b>	4											
<b>F</b>	4	4	4	4								
<b>G</b>												
<b>H</b>			3	4								
<b>I</b>			3	4								
<b>J</b>			2	4	3							
<b>K</b>						4	2	4	3	4	4	4
<b>L</b>												
<b>M</b>												

### STL-2 Understanding the core concepts of technology

	20	28	21	10	33	14	10	33	33	33	36
<b>A</b>	4										
<b>B</b>	4										
<b>C</b>	4										
<b>D</b>	4										
<b>E</b>	4										
<b>F</b>	4										
<b>G</b>	4										
<b>H</b>	4										
<b>I</b>	4										
<b>J</b>	4										
<b>K</b>	4										
<b>L</b>	4										
<b>M</b>	4										
<b>N</b>	4										
<b>O</b>	3										
<b>P</b>	3										
<b>Q</b>	3										
<b>R</b>	3	4									



**KEY**  
 4 = Benchmark must be covered in detail, lessons and assessments cover this content  
 3 = Benchmark is covered, but topics and lessons do not center on them  
 2 = Topics and lessons refer to previous knowledge and integrate content covered  
 1 = Topics and lessons refer to previous knowledge

172	232	212	147	166	202	204	182	236	212	187
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

K#	3-4	Engineering Technology	Invention & Innovation	Technological Systems	Foundations of Technology	Technological Skills & Impact	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Design
S		4								
T		4	3							
U		3	4							
V		3	4							
W						3	4	4	4	4
X					4			3	4	4
Y					3	4	4	3	4	4
Z					3	4	2	2	4	4
AA						2	4	4	4	4
BB						2	3	4	3	4
CC					4	3	4	3	4	4
DD						3	3	2	4	4
EE						3	2	3	4	4
FF						4	4	4	4	4

STL-3	4	8	6	5	12	11	9	12	10	10	12
A	4										
B											
C	4										
D											
E				3	2	4					
F				3	4						
G				3		4					
H							3	2	4	4	3
I							3	4	3	4	4
J							2	3	4		4

**Technology and Society**

STL-4	4	8	14	11	3	2	15	6	7	8	4
A	4										
B											
C	4										
D											



**KEY**  
 4 = Benchmark must be covered in detail, lessons and assessments cover this content  
 3 = Benchmark is covered, but topics and lessons do not center on them  
 2 = Topics and lessons refer to previous knowledge and integrate content covered  
 1 = Topics and lessons refer to previous knowledge

		172	232	212	147	166	202	204	182	236	212	187
K4	K3	Exploring Technology	Invention & Innovation	Technological Systems	Foundations of Technology	Technological Nature & Impact	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Data		
		E	Technology, by itself, is neither good nor bad, but decisions about the use of products and systems can result in desirable or undesirable consequences.	4	3	3						
F	The development and use of technology poses ethical issues.	3	4									
G	Economic, political, and cultural issues are influenced by the development and use of technology.	3	4									
H	Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.				4	2	3	4				
I	Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.				2	4						3
J	Ethical considerations are important in the development, selection, and use of technologies.					3	4	4	4			4
K	The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.					4						2
<b>STL-5 Understanding the effects of technology on the environment</b>		4	8	8	6	9	3	22	11	13	13	11
A	Some materials can be reused and/or recycled.	4										
B	Waste must be appropriately recycled or disposed of to prevent unnecessary harm to the environment.	4										
C	The use of technology affects the environment in good and bad ways.	4										
D	The management of waste produced by technological systems is an important societal issue.			4		3						
E	Technologies can be used to repair damage caused by natural disasters and to break down wastes from the use of various products and systems.				3	4						
F	Decisions to develop and use technologies often put environmental and economic concerns in direct competition with one another.			4	3	2						
G	Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling.								4	3	2	3
H	When new technologies are developed to reduce the use of resources, considerations of trade-offs are important.								3	4	2	3
I	With the aid of technology, various aspects of the environment can be monitored to provide information for decision making.								4		2	
J	The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.								4			
K	Humans devise technologies to reduce the negative consequences of other technologies.								3	4	3	3
L	Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment.								3	4	4	3
<b>STL-6 Understanding the role of society in the development and use of technology</b>		4	8	13	12	2	4	10	4	3	3	4
A	Products are made to meet individual needs and wants.	4										
B	Because people's needs and wants change, new technologies are developed, and old ones are improved to meet those changes.	4										
C	Individual, family, community, and economic concerns may expand or limit the development of technologies.	4										
D	Throughout history, new technologies have resulted from the demands, values, and interests of individuals, businesses, industries, and societies.			4								
E	The use of inventions and innovations has led to changes in society and the creation of new needs and wants.			3	4							
F	Social and cultural priorities and values are reflected in technological devices.			3	4	2						
G	Meeting societal expectations is the driving force behind the acceptance and use of products and systems.			3	4							
H	Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.								4			
I	The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures.								3	4		4
J	A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest trends contribute to shaping the design of and demand for various technologies.								4	3	3	3



**KEY**  
 4 = Benchmark must be covered in detail, lessons and assessments cover this content  
 3 = Benchmark is covered, but topics and lessons do not center on them  
 2 = Topics and lessons refer to previous knowledge and integrate content covered  
 1 = Topics and lessons refer to previous knowledge

172	232	212	147	166	202	204	182	236	212	187
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

K#	3-4	Engineering Technology	Invention & Innovation	Technological System	Foundations of Technology	Technological Milestones & Impact	Technological Design	Advanced Design	Advanced Technological Applications	Engineering Design
<b>STL-7 Understanding the influence of technology on history</b>										
A	4	The way people live and work has changed throughout history because of technology.								
B	4	People have made tools to provide food, to make clothing, and to protect themselves.								
C		Many inventions and innovations have evolved by using slow and methodical processes of tests and refinements.								
D		The specialization of function has been at the heart of many technological improvements.								
E		The design and construction of structures for service or convenience have evolved from the development of techniques for measurement, controlling systems, and the understanding of spatial relationships.	4							
F		In the past, an invention or innovation was not usually developed with the knowledge of science.	4							
G		Most technological development has been evolutionary, the result of a series of refinements to a basic invention.		4						
H		The evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools and materials.			3					
I		Throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape.				4				
J		Early in the history of technology, the development of many tools and machines was based not on scientific knowledge but on technological know-how.				4				
K		The Iron Age was defined by the use of iron and steel as the primary materials for tools.			4	3				
L		The Middle Ages saw the development of many technological devices that produced long-lasting effects on technology and society.			4	3				
M		The Renaissance, a time of rebirth of the arts and humanities, was also an important development in the history of technology.			4	3				
N		The Industrial Revolution saw the development of continuous manufacturing, sophisticated transportation and communication systems, advanced construction practices, and improved education and leisure time.			4	3				
O		The Information Age places emphasis on the processing and exchange of information.			4	3	3	3	3	

**Design**

	8	8	11	10	3	13	4	15	16	15
<b>STL-8 Understanding the attributes of design</b>										
A	4	Everyone can design solutions to a problem.								
B	4	Design is a creative process.								
C	4	The design process is a purposeful method of planning practical solutions to problems.								
D	4	Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.								
E		Design is a creative planning process that leads to useful products and systems.	3	4	3					
F		There is no perfect design.	4	3						
G		Requirements for a design are made up of criteria and constraints.								
H		The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.				4	3	4	4	3
I		Design problems are seldom presented in a clearly defined form.				3	4	4	3	4
J		The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.				3	4	4	4	4
K		Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.				3	4	4	4	4



**KEY**  
 4 = Benchmark must be covered in detail, lessons and assessments cover this content  
 3 = Benchmark is covered, but topics and lessons do not center on them  
 2 = Topics and lessons refer to previous knowledge and integrate content covered  
 1 = Topics and lessons refer to previous knowledge

	172	232	212	147	166	202	204	182	236	212	187
	8	12	11	10	0	13	5	14	10	10	15
	4	4	4	4	4	4	4	4	4	4	4
<b>STL-9 Understanding engineering design</b>											
A	The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.										
B	Expressing ideas to others verbally and through sketches and models is an important part of the design process.										
C	The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.										
D	When designing an object, it is important to be creative and consider all ideas.										
E	Models are used to communicate and test design ideas and processes.										
F	Design involves a set of steps, which can be performed in different sequences and repeated as needed.										
G	Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.										
H	Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.										
I	Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.										
J	Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.										
K	A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.										
L	The process of engineering design takes into account a number of factors.										
<b>STL-10 Understanding the role of troubleshooting, R&amp;D, innovation &amp; innovation, and experimentation in problem-solving</b>											
A	Asking questions and making observations helps a person to figure out how things work.										
B	All products and systems are subject to failure. Many products and systems, however, can be fixed.										
C	Troubleshooting is a way of finding out why something does not work so that it can be fixed.										
D	Invention and innovation are creative ways to turn ideas into real things.										
E	The process of experimentation, which is common in science, can also be used to solve technological problems.										
F	Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system.										
G	Invention is a process of turning ideas and imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it.										
H	Some technological problems are best solved through experimentation.										
I	Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.										
J	Technological problems must be researched before they can be solved.										
K	Not all problems are technological, and not every problem can be solved using technology.										
L	Many technological problems require a multidisciplinary approach.										
<b>Abilities for a Technological World</b>											
<b>STL-11 Abilities to apply the design process</b>											
A	Brainstorm people's needs and wants and pick some problems that can be solved through the design process.										
B	Build or construct an object using the design process.										
C	Investigate how things are made and how they can be improved.										



**KEY**  
 4 = Benchmark must be covered in detail, lessons and assessments cover this content  
 3 = Benchmark is covered, but topics and lessons do not center on them  
 2 = Topics and lessons refer to previous knowledge and integrate content covered  
 1 = Topics and lessons refer to previous knowledge

	172	232	212	147	166	202	204	182	236	212	187
	K2	3-4	Engineering Technology	Invention & Innovation	Technological Systems	Foundations of Technology	Technological Skills & Impact	Technological Design	Advanced Design	Advanced Applications	Engineering Design
D		4									
E		4									
F		4									
G		4									
H			3	4							
I			3	4							
J			4								
K			4								
L			4	3	3						
M						4					
N						4		3	4	3	3
O						4		3	4	4	3
P						3		3	3	4	4
Q						3		4	4	4	4
R						4		3	3	3	3

STL-12	Abilities to use and maintain technological products and systems	12	16	8	3	13	20	5	0	11	11	0
A	Discover how things work.	4										
B	Use hand tools correctly and safely and be able to name them correctly.	4										
C	Recognize and use everyday symbols.	4										
D	Follow step-by-step directions to assemble a product.		4									
E	Select and safely use tools, products, and systems for specific tasks.		4									
F	Use computers to access and organize information.		4									
G	Use common symbols, such as numbers and words, to communicate key ideas.		4									
H	Use information provided in manuals, protocols, or by experienced people to see and understand how things work.			4								
I	Use tools, materials, and machines safely to diagnose, adjust, and repair systems.			4	3							
J	Use computers and calculators in various applications.			4	3	2						
K	Operate and maintain systems in order to achieve a given purpose.					4						
L	Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.						4	2		3	3	
M	Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it.						4			4	4	
N	Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision.						4					
O	Operate systems so that they function in the way they were designed.						4					



172	232	212	147	166	202	204	182	236	212	187
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----



**KEY**  
 4 = Benchmark must be covered in detail, lessons and assessments cover this content  
 3 = Benchmark is covered, but topics and lessons do not center on them  
 2 = Topics and lessons refer to previous knowledge and integrate content covered  
 1 = Topics and lessons refer to previous knowledge

	8	12	12	4	4	4	8	4	0	16	4
<b>STL-15 Understanding of and abilities to select and use agricultural and biotechnologies</b>											
A		4									
B		4									
C			4								
D			4								
E			4								
F			4								
G				4							
H				4							
I			4								
J			4								
K					4					4	
L						4					4
M						4					4
N							4				4
<b>STL-16 Understanding of and abilities to select and use energy and power technologies</b>											
A		4									
B		4									
C			4								
D			4								
E			4								
F				4							
G				4							
H				4							
I				4							
J					4					3	4
K					4					3	4
L						4				4	3
M							1	3	4	4	4
N							3		4	4	4







**KEY**  
 4 = Benchmark must be covered in detail, lessons and assessments cover this content  
 3 = Benchmark is covered, but topics and lessons do not center on them  
 2 = Topics and lessons refer to previous knowledge and integrate content covered  
 1 = Topics and lessons refer to previous knowledge

	172	232	212	147	166	202	204	182	236	212	187
K						4			4		
L								4	4		4
M							4	3	4		3
N								4	4		4

## References

- Blais, Richard (2003). Project Lead the Way©. Project Lead the Way, Inc., Clifton Park, NY
- Desborough, Kristin (1998). Career Path Planning for Secondary Students, Institute for Workforce Education, Instructional Materials Laboratory, University of Missouri, Columbia.
- Dyrenfurth, M. J. & Kozak, M. (1991). Technological literacy. Fortieth Yearbook, Council on Technology Teacher Education. Peoria, IL: Glencoe/McGraw-Hill.
- ITEA (2000). Standards for Technological Literacy: Content for the Study of Technology. Reston, VA: International Technology Education Association.
- ITEA (1999). A Guide to Develop Standards-Based Curriculum for K-12 Technology Education. Reston, VA: International Technology Education Association.
- ITEA (1996). Technology for All Americans: A Rationale and Structure for the Study of Technology. Reston, VA: International Technology Education Association.
- ITEA (2006). Engineering byDesignä: A Guide to a National Standards-Based Program Model. Reston, VA: International Technology Education Association.
- ITEA (2006). Engineering byDesignä, Professional Development Guide. Reston, VA: International Technology Education Association.
- ITEA (2009). The Overlooked STEM Imperatives: Technology and Engineering. Reston, VA: International Technology Education Association.
- Katehi, Linda; Pearson, Greg, and Feder, Michael, (eds.) (2009). Engineering in K-12 Education: understanding the status and improving the prospects. Washington, D.C.: National Academy Press.
- MO DESE (1996). Missouri Show-Me Standards. Jefferson City, MO: Missouri Department of Elementary & Secondary Education.
- National Association of State Directors of Career Technical Education Consortium (2002). States' Career Clusters Initiative, Stillwater, OK.
- NSF (2003). The Science and Engineering Workforce Realizing America's Potential. Washington D.C.: National Science Board.
- Pearson, Greg & Young, A. Thomas, (eds.) (2002). Technically Speaking: Why all Americans need to know more about technology. Washington, D.C.: National Academy Press.
- Savage, E., & Sterry, L. (eds.). (1990). A conceptual framework for technology education. Reston, VA: International Technology Education Association.
- The Master Teacher, vol. 21, no. 22, The Master Teacher, Inc., Manhattan, Kansas
- The Master Teacher, vol. 25, no. 35, The Master Teacher, Inc., Manhattan, Kansas
- Wright, Michael D., and Ben K. Yates, (eds.) (2002) Missouri Technology Education Guide. Jefferson City: Missouri Department of Elementary and Secondary Education, Division of Career Education.