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ABSTRACT

This three-section document contains the model curriculum standards, program framework, and process guide that will assist schools in California in providing career-vocational education programs that are responsive to a world marketplace characterized by constantly changing technology. The standards and frameworks can be implemented to provide a K-12 sequenced curriculum that is coordinated and articulated to form a total program. The standards address general employability, occupational clusters, job-specific skills, and student leadership skills. In addition, they complement and reinforce the core academic skills that are applicable to each of the career models. The guide's first section, the model program framework, sets forth the broad conceptual components of the program and defines the application of each component. The model curriculum standards section describes in detail the objectives, application, and organization of the model standards. Each standard is organized in a format that includes an initial statement, the standard, and academic core skills enhancement. Standards are provided for children, for explorations, and for specialized fields. The curriculum process guide section provides information on: (1) the curriculum comparison process; (2) using the state model to construct a course outline; (3) using the model curriculum standards to construct a lesson plan; and (4) teacher-developed student materials. Appendices provide: (1) California Basic Educational Data System codes; (2) a program sequence example; (3) sample district course outline; (4) a glossary; and (5) 30 references. (KC)

Prepared by the
Industrial and Technology Education Unit
Career-Vocational Education Division

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The development of this publication was made possible with the cooperation of the Office of the Contra Costa County Superintendent of Schools, Ronald Stewart, Superintendent, and Charles Priest, Director of Occupational Preparation Programs; the Office of the Ventura County Superintendent of Schools, James F. Cowan, Superintendent, and James Compton, Director of Occupational Education Services; and T. Christopher Almeida, Program Manager, California Department of Education, Career-Vocational Education Division.

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I am extremely proud of the career-vocational education model curriculum standards and program frameworks. They are a direct and powerful answer to the widespread demand by business and industry for the redirection and restructuring of vocational education in California. The standards and frameworks will allow schools to provide career-vocational education programs that are responsive to a world marketplace characterized by constantly advancing and changing technology.

The standards and frameworks, when implemented in concert with the *Quality Criteria for High Schools: Planning, Implementing, Self-Study, and Program Quality Review*, will provide students with sequenced curricula that are coordinated and articulated to form a total program. The standards address general employability, occupational clusters, job-specific skills, and student leadership skills. In addition, they complement and reinforce the core academic skills that are applicable to each of the career models.

The model curriculum standards and program frameworks have been distributed to teachers, administrators, curriculum supervisors, and selected college and university faculty throughout California. Chief state school officers and state directors of vocational education have also received the materials, and the response has been excellent. Many states have been using the California draft versions as the basis for constructing their own statewide curricula.

I urge secondary schools, regional occupational centers/programs, and adult schools to use these career-vocational education models as a guide for the reform of their vocational education programs. Implementation of the standards, in conjunction with the *Quality Criteria for High Schools*, will ensure compatibility with current and emerging business and industry requirements and will provide for the continuous reinforcement and application of appropriate core academic skills.

The career-vocational education model curriculum standards and program frameworks will strengthen and enhance each student's potential for successful career entrance and career advancement within the state, national, and global marketplaces.

Bill Honig

State Superintendent of Public Instruction

The planning, development, validation, and refinement of the career-vocational education model curriculum standards and program frameworks took place over a span of five years. Models were developed in the major subject-matter disciplines of agricultural education, business education, health careers education, home economics education, industrial and technology education, and marketing education. The planning and developmental phases involved over 2,000 representatives from all educational levels, including colleges and universities, as well as extensive participation from business and industry.

The validation and refinement phases took place in hundreds of school sites, regional workshops, statewide conferences, and business and industry association meetings. The refined models were reviewed by the Curriculum and Instructional Leadership Branch of the California State Department of Education, and they were approved by Bill Honig, Superintendent of Public Instruction, in November of 1988.

Appreciation is extended to everyone who participated in producing models which so well reflect both the present and emerging economic development needs of California. Particular thanks are extended to our many friends in business and industry for their active involvement in our mutual quest for instructional excellence.

Successful implementation of the models in conjunction with the high school program quality criteria is dependent on a well-planned collaboration effort between academic and career-vocational education teachers with the encouragement and support of site and district administrators and business and industry.

The models are designed to assist schools in building programs that are responsive to both educational reform and technological change. The models will optimize the students' potential in successfully making the transition from school to work or from school to more advanced education and training.

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Curriculum has received considerable attention in recent years. Prompted by a U.S. Department of Education report, *A Nation at Risk*, the Legislature passed the Education Reform Act of 1983 (Senate Bill 813), a far-reaching reform measure designed to improve financing, curriculum, textbooks, testing, and teacher and administrator training in the state's elementary and secondary schools. This law mandates sweeping changes in high school graduation requirements and calls for critical reviews of existing high school curricula. It specifically requires the Superintendent of Public Instruction to publish a model curriculum on a cyclical basis and requires high school districts to compare their curricula with the state model every three years.

The State Department of Education, in response, has prepared and published *Model Curriculum Standards, Grades Nine Through Twelve*, representing the academic core subjects.

The present document, *Model Curriculum Standards, Program Framework, and Process Guide for Industrial and Technology Education in California*, is the corresponding model for industrial and technology education curricula.

The document consists of three main parts: the Model Program Framework, Model Curriculum Standards, and the Curriculum Process Guide.

The program framework section describes the overall structure, goals, and components of the program. The curriculum standards section sets forth more than 800 specific standards for three administrative levels representing kindergarten through university programs. The curriculum process guide is a mechanism to help districts compare existing curricula to the model standards.

Common Education Core

Together, the academic core model curriculum standards and the model curriculum standards for industrial and technology education are intended to provide all students with a common education core composed of integrated academic and technical core components. These components enable students to acquire cultural, technical, and scientific literacy and an appreciation for the values that undergird our society. Through this common education core curriculum, students develop the skills of reading, writing, speaking, listening, calculating, learning, and critical thinking.

As expressed in the purpose of SB 813, the rationale for a common body of knowledge is threefold:

1. Society and individuals are far better served when all the members of a society are educated to their maximum potential. (Schools should not arbitrarily determine an individual's ultimate life choice.)
2. Individual choice, commitment, and responsibility are basic premises of the social contract at the heart of our democracy. (Developing these qualities is one of the principal responsibilities of the public schools.)
3. The schools' preoccupation with basic skills in recent years has led to a phenomenon that has been increasingly observed by researchers as well as teachers—students who have learned basic language arts and computational skills but who have little sense of how to use those skills profitably in their lives.

Integral to the central theme of high expectations for content and performance and evolving from the three premises of a strong core curriculum is the dual requirement of schools to offer students opportunities to (1) meet California university admission requirements; and (2) attain entry-level employment skills. The full text of the *Education Code* section requiring these two opportunities is as follows:

> 51228 (a) Each school district maintaining any of grades 7 to 12, inclusive, shall offer to all otherwise qualified pupils in those grades a course of study fulfilling the requirements and prerequisites for admission to the California public universities.
>
> (b) Each school district maintaining any of grades 7 to 12, inclusive, shall offer to all otherwise qualified pupils in those grades a course of study which provides an opportunity for those pupils to attain entry-level employment skills in business or industry upon graduation from high school.
>
> (c) Any school district which adopts a required curriculum that meets or exceeds the model standards developed by the State Board of Education pursuant to Section 51226 shall be deemed to have fulfilled its responsibilities pursuant to this section.

In addition to the dual requirement of university admission and entry-level employment skills, California schools are also mandated to provide alternatives in core course requirements for high school graduation. As stated in *Education Code* Section 51225.3(b), this mandate is as follows:

> (b) The governing board, with the active involvement of parents, administrators, teachers, and pupils, shall adopt alternative means for students to complete the prescribed course of study which may include practical demonstration of skills and competencies, supervised work experience or other outside school experience, interdisciplinary study, independent study, and

credit earned at a postsecondary institution. Requirements for graduation and specified alternative modes for completing the prescribed course of study shall be made available to pupils, parents, and the public.

Tied to these educational alternatives is a mandated evaluation system, as prescribed to schools in *Education Code* Section 48431.6, for the review of an individual student's options within the dual requirement of university admission and entry-level employment skills. Key to this evaluative provision for postsecondary education and employment are the options listed in Section 48431.6(b):

> Educational options shall include, but not be limited to, regional occupational centers and programs, continuation schools, academic programs, and any other alternatives available to pupils of the district

Industrial and Technology Education Core

The technical core complements and reinforces the academic core, providing alternative paths through the common education core. In particular, industrial and technology education courses offer content comparable to academic core courses and provide opportunities for students to understand career options, helping them to evaluate career choices and to prepare to select careers.

The model framework for industrial and technology education in California spans all educational levels from kindergarten through the university level. The program incorporates traditional, general, and industrial vocational education, including trade and industrial education, technical education, and industrial arts education. It consists of well-planned, articulated, and sequential educational experiences that prepare individuals for successful participation in work and the community. It encompasses awareness of career options, exploration of jobs, career guidance, establishment of career goals, development of workplace skills, development of personal and leadership skills, and the establishment of safety practices and attitudes. The model also addresses gender equity and special needs agendas. It includes entry-level preparation, career advancement, including advanced training and retraining, and entrepreneurship.

Industrial and technology education has the dual purpose of benefitting individuals as well as society as a whole. All students are to achieve a core of common learning that enables them to understand, participate in, and carry on the civilization in which we live. Beyond this common core are offered electives and specialized courses designed to give all students the opportunity to prepare themselves for higher education or the workplace. Students are to be enrolled in the most challenging and engaging sequence of courses possible for honors, advanced placement, college preparation, vocational-technical education, general education, and remediation. Taken together, the core and the specialized courses are to provide a path for students to develop to their greatest potential and to be able to achieve postsecondary goals. All students—male and female, the gifted and the disadvantaged, the handicapped, minority, and nonminority students—have the right to select a career and to receive education and training to make their goals possible.

This section sets forth the broad conceptual components of the program and defines the application of each component. It then describes specific elements of the program essential to the successful achievement of a common core.

Component: Technical Core/Academic Core

The industrial and technology education core forms a powerful and positive linkage with the academic core. The technical core provides an enhancement of the academic core through which students can reinforce their academic skills and successfully compete in our economy as productive citizens. When the technical core is provided within the context of a total sequential program concept, a student will be able to plan intelligently and properly prepare for a career goal.

Application: Technical Core/Academic Core

- Technical core content provides a positive, instructional strategy for enhancing the academic core.
- Technical core courses and academic core courses with supportive services are provided to students in a logically sequential total program concept (general to specific and simple to complex) with constant reinforcement of the theoretical through direct, practical application.

Component: Excellence and Accountability

Quality technical core programs and supportive services can be achieved when standards of excellence are designed so as to challenge all students. Quality criteria exist to measure progress in achieving model curriculum standard outcomes and to serve as quality indicators to determine actual achievement.

Vocational instructional programs, courses, and services are evaluated on the basis of student success in meeting program, course, or service objectives. Objectives are based on business/industry standards and include acquisition or reinforcement of basic and employability skills. Programs, courses, and services are in compliance with State Board of Education standards and are reviewed by a wide spectrum of business/industry and educational personnel. Standards of excellence are only possible through a cooperative partnership between education and business and industry. Business/industry programs use business and industry personnel for curriculum input, to supply current and future job market data, to provide applied experiences and job placement opportunities for students, and to validate program standards and criteria.

Application: Excellence and Accountability

- *The Model Curriculum Standards, Program Framework, and Process Guide for Industrial and Technology Education in California* is the basis for review of and cross-referencing to the model academic core curriculum standards.
- Elementary school program quality criteria and secondary school

program quality criteria will be the base for measuring progress in meeting standards.

- A technical core quality indicator in the statewide accountability program relating to courses that meet national or state standards of quality will be an indicator of standard achievement.
- Class enrollments are limited in size so as to ensure successful, safe, and cost-effective instruction.
- Vocational instructional programs are operated in accordance with stated objectives and include appropriate class time and applied experience to prepare students for identified occupations or advanced vocational training.
- There will be increased involvement of business and industry in the development, implementation, and review of all standards.

Component: Articulation

The articulation and coordination of instruction among and within all institutions providing career-vocational education programs and services is critical in providing a systematic, sequential, program approach. Joint planning involving teaching, guidance and counseling, and administrative personnel from all levels of institutions is integral to the effective delivery of a quality career-vocational education program. To ensure cooperation among the deliverers of vocational education in California, area articulation and coordination committees, composed of equal representation from secondary schools, adult education, ROP/Cs, community colleges, and business/industry, should be formed. A committee's service area should be that served by the community college district or other appropriate geographic area.

In the determination of where programs should be offered, consideration should be given to the following: maximum utilization of existing equipment and facilities; maintenance of existing successful programs that reflect business and industry standards and student needs; availability of qualified instructors; and labor market information.

Area Articulation and Coordination Committees

Committees should consider the uniqueness of each agency in providing programs that would be most appropriate to the ability levels of the students. The committees should develop long-range and yearly articulation plans to address effectively the vocational education needs of that community.

Long-range Plan

A long-range plan should be developed for each local area and should take into account factors such as the following: rapidly changing technology and working environment; emerging occupations; most efficient use of resources; interagency cooperation; identification of programs and services available to students/clients; information and data needs for policy decision making, evaluation, and accountability; elimination of unnecessary duplication; and locale of employment/population mobility.

Yearly Plan

An articulation plan should be developed and updated each year by the area articulation and coordination committee. The plan should reflect the stated long-range plan; provide for review of existing and proposed programs and indicate approval or disapproval of these programs; and indicate agreements among agencies to accept courses completed at the sending institution as meeting specific course requirements at a receiving institution.

Articulation of Secondary Schools, Adult Education, ROP/Cs, and Community Colleges

Area articulation and coordination committees should encourage development of a process to allow students to waive classes or portions of classes for which they have developed the required competencies.

Teachers and administrators should cooperatively develop program standards to ensure that comparable courses offered at each institution grant equal credit for equal work. Area plans should facilitate the articulation of students from one institution to another. Vocational teachers should work cooperatively with academic teachers to (1) identify basic skills appropriate for vocational courses; and (2) identify real-life applications of basic skills appropriate to academic courses.

Application: Articulation

- Local plans will be developed that are reflective of the model curriculum standards and program framework for industrial and technology education and quality criteria.
- Area planning that coordinates and facilitates career-vocational, occupational, technical, and professional education will be piloted.
- There will be administrative support for the cooperative planning and articulation between academic and career-vocational education teachers to provide complementary curriculum and instruction.
- Active planning and coordination will increase among academic and career-vocational education teachers and administrators and business and industry personnel in curriculum planning, development, and evaluation.
- 2+2—which is articulated, coordinated, and sequential curriculum and instruction: two years at the comprehensive high school, regional occupational center/program, or adult school and two years at the community college—will be implemented.
- 2+2+2—which is the same as 2+2, coupled with two additional years at a college or university—will be implemented.

Component: New Technology

One significant challenge to career-vocational education is helping students obtain not only the skills, knowledge, and attitudes to enable them to be successful in obtaining employment in the career of their choice but also the transition skills necessary to enable them to work with the changing technologies of the future. Rapid and constant technological changes affect career-vocational education programs and services on an almost daily basis. Processes, technologies, systems, information, and equipment change, and so must career-vocational education if it is to remain viable and relevant.

Technological change requires that our students possess a strong foundation in core academic skills, a broad base of career cluster skills, and specialized advanced level skills within the career field of their choice.

Academic and vocational courses are organized into programs leading to graduation and entry into identified occupations or advanced training.

Application: New Technology

- There will be gradual transition by high schools in using state-of-the-art systems, computers, and equipment that simulate those used by modern business and industry.
- Involvement and active participation of business and industry will be expanded to ensure the relevancy of curriculum, equipment, and instructors.
- Cooperation and coordination with approved teacher preparation institutions will be increased to ensure that new teachers possess the skills necessary for addressing educational reform and technological change.
- Cooperation and coordination with colleges, universities, business, and industry in maintaining, strengthening, and updating teacher academic and career-vocational skills will be increased.

Elements

Model framework elements essential to the successful achievement of a common core include skills and concepts that are interwoven throughout the entire industrial and technology education program. Model framework elements include the need for adequate facilities, equipment, and materials; business and industry relationships; skills necessary for employability; gender equity; guidance and counseling; staff improvement processes; guidelines for instructional practices; integrated/transferable skills; leadership skill development; program planning and review; organization and content; qualified personnel; safety; special needs—MERGE; and supervised field experience.

Facilities, Equipment, and Materials Based on Current Technology

Adequate facilities, equipment, and materials should be provided by both education and business/industry for vocational courses and should be of sufficient quality and quantity to enable students to acquire vocational skills that meet business/industry standards.

Business and Industry Relationships

Inasmuch as the business community represents the arena where students who have been trained in public educational institutions will most likely be employed, it is extremely important that a close working relationship between business and education be established. This relationship should be one that involves business and education in a partnership to determine each phase of a process, the end product of which is a competent, productive employee who will be able to assume a position in the business world and be successful.

Several organizations, including the California Industry Education Council and its local chapters, the education committees of the state and local chambers of commerce, and established vocational education advisory councils, provide established communication links between education and business and industry. Therefore, it is recommended that these types of established organizations be used to facilitate the following cooperative efforts.

Determination of needs. Local educators should communicate with the private sector to determine the needs of business and industry as to the skills, habits, and attitudes desired in employees.

Educators should collect, analyze, and use demographic, economic, and labor market data to ensure that educational programs are designed to meet current and anticipated market needs.

Educators should review programs annually to ensure that program changes are made in response to changes in needs and to ensure that unnecessary duplication of effort is avoided.

Educators should use advisory councils and other business-education partnerships to ensure that relationships between needs and programs exist.

Involvement in programs. Educators should involve business and industry in the assessment of current programs.

Educators should expand industry and business involvement in vocational programs at the local level through such activities as work experience and intern programs.

Educators should involve business and industry in validating competency levels and student achievement and in setting performance criteria for students involved in vocational education programs.

Educators should have business and industry provide school-to-workplace transitional opportunities for students.

Educators should expand opportunities for publicity about current programs through such means as television, print media articles, press releases, and open houses.

Educators should use private sector expertise in teaching classes, as appropriate.

Educators should inform business and industry of education's ability and willingness to develop classes to meet immediate specific needs with their support or financial assistance.

Educators should use private sector expertise in developing or updating a curriculum that combines vocational and basic skills that meet current high school graduation requirements.

So that educators may more easily keep current in their subject matter, it is recommended that teacher-business exchange programs be developed or expanded in cooperation with those organizations previously listed. These programs, which provide the classroom teacher with current examples of the practical applications of the courses they teach, should be considered for all disciplines, not just vocational classes. English teachers, for example, could learn how their students will apply principles of English in the workplace. Similarly, the electronics teacher could learn how his or her students apply the principles learned in electronics. These programs help to keep course content updated, particularly in the vocational skills areas.

Establishment of teacher-business exchange programs provides an immediate and practical way of updating course content, since the teacher is immediately aware of what is needed in the workplace. Such programs also validate teachers' efforts and provide a valuable link between the classroom and the "real world."

Employability Skills

To be successful in a career, students must possess a foundation of knowledge, attitudes, abilities, and behaviors that are applicable to all employment situations. These characteristics, as specified in *Model General Occupational/Employability Skills* (1986), are as follows:

- Proficiency in mathematics and English language skills
- Ability to apply academic skills to employment situations
- Desirable work attitudes and habits, such as dependability and responsibility
- Good interpersonal communication, problem-solving, and decision-making skills
- Knowledge about careers, career planning, and job seeking skills
- Ability to adapt to change

Instruction on this subject and the development in students of the appropriate habits and attitudes require a multifaceted approach. This includes instruction on and experiences with specific components, such as letter writing and resume development. Of equal importance is the cultivation and reinforcement of attitudes and interpersonal skills best developed through work-situation-related experiences in the laboratory and shop.

Opportunities for students to practice and expand on these key skills, abilities, and habits are emphasized throughout this curriculum via instruction and hands-on experience.

Gender Equity

There is a growing need for all educators and education administrators to recognize major economic and social adjustments in the responsibilities, roles, and perceptions of males and females. Industrial and technology educators play a key role in providing career options for all students.

Language. Language is a powerful tool in the communication of opinions and attitudes to others. Language usage, verbal and nonverbal, requires continuous review and careful evaluation. Words and phrases must appropriately support gender equity.

Curriculum and instructional materials. Gender bias and role stereotyping in curriculum, including assigned readings, instructional media, and textbooks, must be carefully evaluated to produce gender-neutral instructional materials. With a shift from historically gender-specific programs to equal opportunity programs, educators must review methods, materials, and course assignments for any bias as to language, character traits, social roles, occupational roles, physical appearance, avocational roles, patronization, racial stereotypes, numerical balance/omission/inconsistency, and symbolic representation.

Teaching behaviors. Educators/administrators at all levels are models for all students. Attitudes and behaviors of students concerning gender-neutral treatment of others are significantly modeled after the adult model observed. Each gender must have equal access to program content, instruction, learning activities, materials, and equipment and be subject to equal evaluation procedures, rules of conduct, disciplinary procedures, standards of behavior, and safety/sanitation requirements.

All students are to have equal opportunities and experience widespread access to quality instruction. Attention to equity and access is apparent in the design and implementation of the curriculum and the scheduling process. Regardless of gender, ethnicity, or handicapping conditions, students must have access to vocational-technical education programs related to their career interests.

Guidance and Counseling

Guidance for career-vocational education is required to provide a comprehensive, quality industrial and technology education program. Students follow their own path through school and must receive guidance to follow a path that will be a challenging sequence of courses that meet their individual goals, needs, and aspirations. Students are encouraged to develop a long-range perspective and to clarify their goals accordingly.

All students must have equal opportunities and experience widespread access to quality instruction. Attention must be paid to equity and access in the design and implementation of the curriculum and in the scheduling process.

Parents, teachers, and counselors should help students set a path that aims toward their highest, most realistic goals. Students are able to discuss their program of studies, life goals, and career ambitions with their teachers and counselors. A schoolwide system of guidance must facilitate such interaction and emphasize the collaborative nature of the processes of course selection.

Taken together, the academic core and technical core provide a path for students to develop to their greatest potential and be prepared to achieve their goals. Students should have alternatives for acquiring skills and knowledge and should be encouraged to set career goals and to plan a path through school that will prepare them to achieve their goals.

Staff Improvement Processes

The improvement processes are those activities that involve the school and its staff in continuous organizational, curricular, and personal development in order to improve the quality of the instructional program, the environment and culture of the school, the skills of the staff, and student learning. The criteria for assessing the professional and institutional renewal efforts at the school revolve around the extent to which the activities promote a high-quality educational program. A key goal for the school as an organization is the instituting of an effective and meaningful improvement process.

Instructional Practices

Teachers must know the central issues, the major works and people, and the primary methods of thought and communication associated with the subject area they are teaching. They should model genuine interest and enthusiasm for the subject, show the students what is interesting, and excite in them a desire to learn more about the subject. Learning time should be concentrated on the important priorities of the subject, and students should be taught how to learn the subject and how to evaluate the relative importance of its varied content. School leaders should support staff members' efforts to improve instruction and should be knowledgeable about curriculum and instructional practice.

Students should engage in the methods of thinking and the communication methods characteristic of the discipline. Classroom activities should encourage students to develop and elaborate ideas, to synthesize new knowledge with their own previously acquired ideas, and to express these ideas orally and in writing. Students should periodically explore selected topics in an in-depth manner with parts of projects completed over extended periods. The proportion of learning time allocated to such projects and the average length of time per project should increase over the duration of the course and over grade levels.

Lessons should be designed so that students experience a complete learning cycle. Students should be prepared for the new content; the content should be introduced, then taught to the students; the students should apply the content first with guidance and feedback, then independently; finally, they transfer the content to new situations in synthesis with other content. Throughout this cycle, more frequently in the early phases, the teacher should monitor the understanding of the students, adjusting and reemphasizing as necessary. Teachers should employ a wide repertoire of teaching methods to match the kind of learning desired, style of learning, style of teaching, type of content, and resources available. The instruction the students receive should provide them with the skills and knowledge necessary to develop the capacity to think and learn on their own.

Students should have frequent opportunities to employ their strengths and interests in learning activities. Variations in assignments and teaching methods should be used when needed to match student needs and ways of learning; help should be given when students need it. Pace, depth, and focus should be adjusted to keep students of every ability level engaged in learning common topics. Students should understand the purpose of their assignments and what they are expected to do; they should know what they will learn by completing the work; and they should have a good chance of doing so successfully. Students with language difficulties should engage in guided language development activities appropriate to each subject taught. A student's motivation to learn should be recognized and encouraged throughout the school.

Classroom discussions should be used to help students recognize the central issues of the subject and to analyze, synthesize, and evaluate what they are learning. Students of every level of ability should be asked questions of appropriate difficulty. Classroom discussion should stimulate students' interest in the subject. All students should feel free to participate in classroom learning activities and take an active part in the class. Teachers should respond frequently and informatively to students' responses.

Expectations for a learner's behavior should be clearly defined and consistently maintained. Grading policies and standards should be known to students and parents and should be applied fairly. Students should be alerted to their progress and provided specific suggestions for improvement at regular intervals. Students should receive prompt feedback on their completed assignments.

The allocation of the teacher's attention to groups and individual students should be balanced, timely, and fair. Positive verbal and nonverbal support encourages learning effort and progress. Interactions should be guided by the evident belief that all students can and will learn. Time should be managed to maximize learning. Student attention to the learning activity should not be disrupted by other students, announcements, or other noninstructional events. Nor should they have to wait for directions, clarifications, or required materials. Excellence in work and assignments should be exhibited by students at all levels of achievement; the craft of learning should be taught and nurtured in day-to-day activities. Students should be taught to help each other learn.

Development of Integrated/Transferable Skills

Students across grade levels should develop and use the skills of thinking, learning, listening, speaking, writing, reading, and calculating. Written schoolwide policies and departmental implementation plans should ensure that these skills are developed in all students, regardless of the paths the students take through school. Uniform expectations for development of skills should be practiced departmentwide and schoolwide. All departmental plans specify the skills developed in each course offered by the department and describe how the skills are integrated in each subject-matter area. Departmental plans should set up a system that enables progressive and developmental skill training. Faculty members should be implementing the departmental plans in each course syllabus.

As a result of this focus on integrated skills, students at lower and average levels of achievement should be able to move into a more demanding curriculum. An emphasis on integrated skills in core courses in the first two years of high school will give these students both the skills and content needed to succeed in the more demanding curriculum. At the same time, it will strengthen students' skills in higher-level courses, challenging them to excel continually.

All students should be expected to increase their thinking skills. Assignments should require students to regularly use higher-level mental processes that include analysis, interpretation, evaluation, problem solving, application of principles, and creativity. Faculty members should continually model such skills, and the materials of instruction, the learning and teaching process, and the methods of testing should reflect this emphasis on higher-level mental processes. Schoolwide support for raising expectations for students' thinking should be present; and parents, students, and community members should understand and support the commitment to developing each student's thinking skills. Students should receive regular feedback on their skill development progress. Time and effort should be taken to extend the students' proficiency levels in each of the integrated skills. Students should receive instruction and assistance in library and media use and learn how to access and use a variety of information sources. The library should offer ample collections of books that support extension of students' interest in the priority curricular objectives of the school, thus enabling students to explore and research in an in-depth manner.

Libraries should be open before and after school to encourage the maturation of students as independent learners. Libraries should offer support services for teachers to integrate library use in regular assignments.

The faculty in-service program should address the training needed by the faculty to become increasingly proficient in planning and executing objectives of skill development in their courses. Administrators and faculty members should continue to raise their own levels of skills through both in-service and personal development programs.

English/Language Arts. The English/language arts curriculum should be comprehensive, systematic, and developmental. The curriculum should be organized around a central core of literary works selected from among the great essays, poems, short stories, novels, biographies, dramas, folktales, and speeches that preserve and embody the diverse cultural heritage of the United States. English teachers should use literature both (1) as the medium for teaching the fundamental human, ethical, cultural, and political values that underlie our society and connect us as human beings; and (2) as the means for teaching reading, writing, listening, speaking, and thinking skills at all grade levels. The curriculum should be developmentally sequenced so that all students gain an increased understanding of the works of literature that are studied and are better prepared to read and comprehend similar works on their own. The literature curriculum should have three parts, encompassing a core, an extended reading program, and a recreational/motivational reading program. The core program should consist of those works that are intensively studied and discussed on a classwide basis. The extended program should consist of similar works selected by students with the teacher's guidance. The recreational/motivational reading program should develop the reading habits of students and instill in students the lifelong pleasures and rewards of reading.

History–social science. The history-social science curriculum and instruction should (1) vitalize history as the link between past and present; (2) highlight the breadth of perspective by teaching students to experience history-social science through the mind and eyes of the historian, geographer, economist, technologist, anthropologist, sociologist, psychologist, theologian, and humanist; (3) include instruction in geography so that the critical roles of the environment, location, resources, and demography can be better understood; (4) teach the basic values and principles of our democratic, constitutional system and the pluralistic nature of our state and nation and compare our system to other systems; and (5) promote the acquisition of academic, civic, and social skills. The foundation of the curriculum is history—the narrative account of events and their development and consequences.

Mathematics. The primary objective of mathematics instruction is to develop the students' mathematical understanding—the ability to discern mathematical relationships, to reason logically, and to use mathematics techniques effectively. All students should master the major concepts and skills of each strand of mathematics: number, measurement, geometry, patterns and functions, statistics and probability, logic, and algebra. The curriculum should continually reinforce and extend the previously learned mathematical concepts and skills through problem assignments that require the use of these concepts and skills in a variety of new situations with real-world settings. The relationships among concepts and skills, both old and new, should be stressed in all classes so that students can connect new or extended concepts to what they already know. The students should experience mathematics as a cumulative, unified subject.

Science. The primary goal of the science program is scientific literacy for all students. Students should develop scientific literacy by developing interest and enjoyment in learning how things work and why things are; learning fundamental concepts of science and how the application of these concepts affects their daily lives; learning techniques of the scientific method to validate scientific knowledge; developing thinking skills for lifelong learning; and using attitudes and knowledge about science to live as informed citizens in a scientifically developed nation. Students should have positive attitudes toward science and take an active interest in science.

Visual and Performing Arts. The primary focus of the arts curriculum is to prepare students to express their creativity and to incorporate art into their lives. Students should be enthusiastic about their participation in the arts and should be motivated by the success of their own artistic endeavors. Instruction should concentrate principally on practicing artistic activities, developing artistic skills and techniques, and creating artistic products. Courses should concentrate on gaining the knowledge and mastering the skills and techniques needed to make creative self-expression possible. The creative activities in which the students are engaged should promote personal insight, emotional satisfaction, and spiritual nourishment.

Leadership Skill Development

In addition to developing occupational skills, industrial and technology education courses and programs must focus on the personal skills and attitudes that serve as a foundation for career planning and lifelong learning. Students should develop skills in four areas:

Interpersonal skills

- Solving problems in groups
- Making group decisions
- Serving effectively on committees
- Participating actively in meetings

Communication skills

- Preparing written or oral reports
- Delivering oral reports
- Speaking in public
- Introducing speakers
- Writing business letters

Business meeting skills

- Planning business meetings
- Preparing meeting agendas
- Using basic parliamentary procedure
- Organizing special programs or activities

Personal business skills

- Choosing appropriate attire
- Holding business conversations
- Making personal introductions
- Evaluating meetings or programs

Students who actively participate in student leadership development organizations, such as VICA, which are designed to be integral to the instructional program, should be offered a variety of additional opportunities to develop their personal leadership skills.

Program Planning and Review

The planning, operation, and review of vocational instructional programs should be based on an analysis of current and future job market data; recommendations from business/industry personnel; input from students, parents, community, and school representatives; student follow-up studies; and program evaluation.

Course Organization and Content

Vocational education courses should consist of instruction based on skills, knowledge, habits, and attitudes required to perform specific tasks in identified occupations. These courses will help students reinforce or acquire basic academic and employability skills.

Personnel Standards

Vocational courses should be taught by personnel who possess appropriate credentials and related work experience.

Safety

A comprehensive safety program is essential to the success of a quality industrial and technology program. The industrial and technology teacher can give real meaning to safety because in all laboratory activities the need for strict adherence to safety rules is apparent. Every teacher should be interested in protecting students and educating them to live increasingly efficient and satisfying lives. Whenever possible, the teacher should explain how certain safe practices in the shop relate to other activities the student experiences daily at home and at work.

California school districts have a legal responsibility for accidents that involve students while they are participating in school activities to which they have been lawfully assigned. Therefore, school districts should provide physical facilities and equipment designed, constructed, and maintained to ensure a safe learning environment. Also, records should be on file to document the existence of an effective safety program.

A well-coordinated program should include safety instruction geared to the correct use of the tools and equipment in the industrial and technology education facility. By the very nature of industrial and technology activities, the instructor can make training in safety an integral part of every task performed. A safety education program based on industrial safety practices should prepare the students to work safely in the home, school, community, and industry.

Special Needs—MERGE

An important function of public education is to prepare young people to become informed and responsible citizens and to succeed in higher education and productive employment. If all students are to achieve their full potential, schools must provide learning opportunities that will enhance success in these areas.

A segment of the school population requires special assistance to achieve academic success. This population may be physically handicapped, educationally disadvantaged, limited in English proficiency, or gifted and talented.

To assist industrial and technology educators with students who have special needs, a project called MERGE is sponsored by the Industrial and Technology Education In-service Project in the Career-Vocational Education Division, California Department of Education. The project provides assistance to teachers who are teaching students with special needs, making state project resources available. Peer consultants are provided who have had four levels of training in the area of industrial and technology education instruction for learners with special needs. These levels are:

1. Awareness of adapting instruction
2. Problem identification
3. Resource gathering
4. Specific instructional strategies

Project MERGE provides a vehicle for industrial and technology teachers to share teaching strategies and to adapt the ideas to suit particular teaching styles and school situations. This project enables students with special needs to receive the necessary education and instruction on their paths through high school and on to success in the world of work or higher education.

Methods, materials, and assignments used in course work should be appropriate to the special needs and activities of each student, whether those needs result from a handicapping condition, a primary language other than English, or achievement levels significantly above or below those of the majority of students. Special services should provide access to the core curriculum by providing comprehensive instruction that promotes normal progress. Beyond the core curriculum, students with special needs should have access to vocational and college preparatory programs that fit their career goals. Students should develop their potential by means of challenging course work, appropriate course placements, mentorships, and advanced placement whenever possible. For the high-ability or high-achieving student, special services should be available to remove ceilings, raise conceptual levels, and extend the breadth and depth of the core program.

The school environment should encourage academic success for special needs students. Each adult working with students should be knowledgeable about their needs, capabilities, and learning progress and expect them to be successful in school. All adults should enthusiastically assume the responsibility of helping the student with special needs realize his or her potential as a learner by planning and coordinating efforts to provide a coherent and well-articulated program. Work with students should be supported by appropriate staff development activities relating to special needs and should be focused on curriculum, instruction, assessment, and students' achievement.

Special services the students receive should support their acquisition of the core curriculum, and each student with special needs should be expected to master, to the extent of his or her ability, the core curriculum provided to all students. The total curriculum experienced by students should be comprehensive, balanced, and appropriate to the students' career goals. Special services to help students complete and learn from the assigned work of the regular curriculum, rather than displacing the regular curriculum, should be supported and encouraged statewide through the application of MERGE and VERS program personnel and resources in the classroom. Students should experience success in learning the skills and concepts of the curriculum commensurate with their highest potential and should feel positive about themselves as learners.

Supervised Field Experience

Vocational instructional courses should combine and coordinate related instruction with at least one of the following applied experiences in a simulated or business/industry setting: field or classroom laboratory, community classroom, cooperative education, vocational work experience, or other related experience appropriate to the student's vocational objective.

The curriculum standards set forth in this document have been established by the industrial and technology education community in California as the model for the measure of industrial and technology education program quality.

It is important to regard the standards as only a model and to keep in mind that they are written so as to challenge *all* students and to serve as a catalyst to curriculum review and development by teachers, administrators, members of governing boards, and others to build a stronger, richer curriculum for all students in California.

Described below in more detail are the objectives, application, and organization of the model standards.

Objectives

The central purpose underlying the standards in this document is to ensure that *all* students have the opportunity to participate successfully in quality, sequential, coordinated industrial and technology education programs.

Broad objectives inherent in the development of the model standards presented include but are not limited to the following statements:

1. To develop and implement a comprehensive planning process that actively involves appropriate education, community, business, and industry personnel at the site, district, area, and state levels for the purpose of jointly planning, developing, articulating, and implementing programs
2. To provide resources to assist in ensuring that all students receive, as an integral component of a comprehensive career guidance program, a planned, coordinated, interdisciplinary approach that includes education and career assessment, career awareness and exploration, and development of individual education/career plans which are systematically reviewed and updated

3. To provide that students are able to participate in programs designed to accomplish their career-vocational goals and which are offered as a sequential program based upon quality standards that include the use of career-vocational education as an instructional strategy for teaching and enhancing academic core competencies, employability skills, general-to-specific career cluster skills, and either specific occupational skills or advanced academic preparation as determined by the individual student career plan
4. To provide that programs, as sequences of courses, are provided to students as a cooperative, coordinated effort between secondary, ROC/P, adult schools, and California community colleges and universities as an articulated, sequential, and interdisciplinary fusion between academic, career, and vocational education and support services
5. To provide for quality and relevancy of industrial and technology education programs and services provided to students by upgrading the educational, professional, career, and occupational skill proficiency levels of existing and future administrators, instructors, and support personnel
6. To provide that all students have the opportunity to achieve their career goals by offering full access to the necessary support services that will increase their potential for successfully entering and participating in industrial and technology education programs, both traditional and nontraditional to their gender

Application

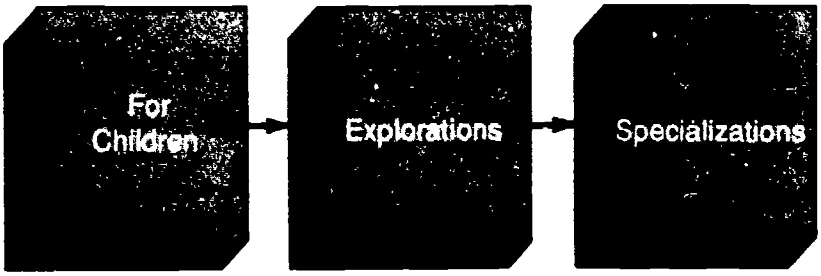
The model standards provided in this document are intended to facilitate the continual refinement of instructional programs according to a variety of societal and economic factors in the state. They address the needs of individuals, of business and industry, and of the educational community. They are dynamic, as they must constantly be modified to keep pace with the changing needs of students, business and industry, and the educational milieu. When technology changes in the workplace, there must be a corresponding change in industrial and technology education programs. Industrial and technology education programs, in addition, must reflect the needs of the society as a whole, moving with changes in educational method, strategy, articulation, and evaluation. Industrial and technology education must keep current and remain flexible in order to continue providing services to the diverse population it serves.

The curriculum process guide is a dual-purpose mechanism to enable the individual or group at the local level—from the local governing boards and superintendents through curriculum specialists, principals, and classroom teachers—to carry out the required comparison of local curricula with the state model and to continually refine instructional programs.

Organization

The industrial and technology model standards are organized according to three administrative levels: industrial and technology education for children (elementary school), industrial and technology education explorations (middle grades), and industrial and technology education specializations (encompassing comprehensive high schools, adult education, regional occupational center/programs [ROC/Ps], and California community colleges and universities). The specializations'

The Three Levels of Industrial and Technology Education



standards, in turn, are organized into seven cluster areas: construction technology; diversified occupations; electronics technology; manufacturing technology; power, energy, and transportation technology; visual communications technology: drafting; and visual communications technology: graphics.

One additional and exciting new model curriculum is included in the document: Principles of Technology, which is a two-year high school curriculum in applied science for vocational-technical students.

In early high school offerings, standards support programs that address a specific cluster, are broadly designed in curricular scope, and are integrated within the common education core to provide for the general education of all students. Occupationally specific and trade and industrial standards for third- and fourth-year comprehensive high school-aged and postsecondary or adult students are likewise found in industrial and technology education specialization cluster areas. Specializations at this level are occupationally specific to one of the seven cluster areas described and integrated with the academic core.

As students proceed through their last two years of high school, industrial technology education specializations provide alternatives, with the assurance that the paths students choose are directly related to their career, personal, and social goals; that bridges exist to help students move from one path to another as they mature and develop through their high school years; and that students are able to take the necessary prerequisite courses for their chosen paths.

Students whose career goals include employment immediately after high school, as well as students who plan to continue their formal education beyond high school, enjoy access to industrial and technology specializations programs from a variety of delivery systems, including: the comprehensive high school, the regional occupational center/program (ROC/P), adult education, and California community colleges and universities.

Format

The industrial and technology education exploration standards and specialization standards have been written in a two-part format. The first part includes an initial statement describing the impetus and need for the standard, and the second part describes the skills or knowledge the student is intended to acquire from the course. In addition, following each group of standards is a list of suggestions pertaining to academic core skills enhancement.

- *Initial statemen.* The introductory statement for each standard focuses upon the technical content or nature of that standard and explains its purpose and significance.
- *Standard.* The standard statement provides a base for curriculum development. Each standard has been written to state what the student will understand or will be able to do upon achieving that standard. In a true model format, each standard is written broadly to inspire the development of precise, developmental statements. It should be reemphasized that standards are basic, essential, yet individually specific statements providing a model for the design of district/program curricula. Model standards should never be interpreted as a model curriculum—but as the basis for the development of a potential model curriculum at the local level. In addition, the reader should be careful to note that the order in which the standards in this document are listed does not necessarily coincide with any traditional course outline. Again, the development of course outlines is the privilege of the individual teacher, district, or program.
- *Academic core skills enhancement.* Industrial and technology education model standards outlined in this document focus on the continued refinement of classroom programs. This new emphasis becomes clearer if the reader envisions and applies the representative academic core skills enhancement activities. Although all the activities are merely suggestions, they represent the quality of thinking and practice envisioned for every classroom/laboratory.

Standards for industrial and technology education for children are designed to enhance and reinforce the attainment of the educational goals of the total elementary school program. Organized by grade levels kindergarten through grade five, the standards identify technological concepts and processes. There, experiences orient pupils to industry and technology, improve personal psychomotor skills, promote cognitive development, and refine attitudes about the influence of technology on society.

The standards are set within three academic core areas of the elementary curriculum: mathematics, science, and history–social science. Representational activities for each standard are provided by academic core topic and grade level as illustrations of curricular integration.

The standards for children:

- Develop technological awareness.
- Allow children to work with tools, materials, and technological concepts and processes.
- Provide opportunities for children to learn fundamental concepts about how people create and control their environments.
- Reinforce and enrich concepts in the sciences, mathematics, history–social science, and other subjects in the elementary school curriculum.

Elementary school teachers should complete a preservice or inservice training program in industrial and technology education before integrating technological concepts into the existing elementary school curriculum. As the standards for industrial and technology education are implemented in existing elementary school classrooms, additional tools, materials, and supplies must be provided to accommodate the children's activity requirements and to address the integration of mathematics, science, and history–social science skills.

Educators should refer to the Program Framework section of this document for a discussion of the broad conceptual components and specific elements guiding the development of the standards listed herein.

Contents

Subject	*Grade*	*Practice Component*
Mathematics	5	Review Addition, Subtraction, and Multiplication Multiplication—1-, 2-, and 3-Digit Division—1-, 2-, and 3-Digit Geometry Time, Measurement, and Money Fractions
	4	Review Addition and Subtraction Facts Multiplication Facts Division Facts Time, Measurement, and Money Geometry
	3	Numbers and Numeration Addition of Whole Numbers Subtraction of Whole Numbers Multiplication of Whole Numbers
	2	Number and Numeration Meanings Patterning Addition of Whole Numbers Subtraction of Whole Numbers
	1	Recognizing Numbers and Numerals Basic Addition Facts and Properties Basic Subtraction Facts and Properties Skip Counting
	K	Position, Classification, and Patterning Recognizing and Counting Numbers 0–20 Geometric Shapes Measurement
Science	5	Plants and Animals of Long Ago Geology Human Biology Light Properties Ecosystems
	4	Life Cycles Electric Light Circuits Solar System Cells, Tissues, and Your Body Vibrations and Sound

Subject	Grade	Practice Component
Science	3	Properties of Air Bones and Muscles Heat and Temperature Communities of Living Things
	2	Moving Things Have Energy Three States of Matter Plants and Seeds Waste Management
	1	Plant and Animal Needs Time Measurement How Things Move Soil and Air
	K	Describing Objects Time Intervals Objects and Motion Properties of Living Versus Nonliving Things
History–Social Science	5	Becoming a Nation—13 Colonies Civil War Westward Movement The United States Grows and Changes The United States in Today's World
	4	Geography of California First Californians and Mission Days Gold Rush California in the New Century
	3	Learning About Communities Living in Different Communities Farms Support Our Community Citizenship in the United States
	2	Where We Work Communities Make Rules Communities Long Ago and Today Celebrating Holidays Around Us
	1	Alike and Different Family Needs Living in Neighborhoods in the United States
	K	About Me Family and Family Needs The Community Around the School Tools

Instructional Strategies for Mathematics

The student should understand relationships between mathematical operations and technological systems.

Integrating technology and mathematics skills within the common education core includes examples such as the following:

Fifth Grade

- *Review Addition, Subtraction, and Multiplication:* Keeping a weather chart in classroom, bringing in newspaper clipping of previous day's temperature to record on chart, then averaging temperature for the week; studying cost of electric heating versus wood/wood-burning stove; keeping a chart in classroom for three months to track monthly gas bills in a home with a gas stove as opposed to a home without a gas stove
- *Multiplication—1-, 2-, and 3-Digit:* Studying probability with a classroom lottery; drawing marbles from a jar (40 marbles—red, blue, green, and yellow), recording each draw on a master chart, putting back into jar, studying the chart, discussing possible makeup of jar (e.g., If drawing more red marbles, possibility that 3/4 of marbles are red—3/4 x 40 = 30 red marbles.); discussing state lottery and using calculators to compute odds; visiting a bottling plant (Coca-Cola, Pepsi) to see how many bottles are filled per minute, per hour, per day and comparing the figures to filling bottles by hand, then setting up problems (e.g., If 20 bottles are filled per minute, how many bottles are filled in 30 minutes?)
- *Division—1-, 2-, and 3-Digit:* Using computers and pencil and paper to compute 25 division problems (already programmed for computer) to see which method gets answers more quickly and correctly; mass-producing 200 (easy recipe) sugar cookies, designing a package, and then deciding which is the most efficient plan for dividing cookies evenly among packages
- *Geometry:* Constructing paper airplanes, using different shapes for wing design, having a flying contest to determine best design, longest flight; comparing to modern aircraft; constructing solar ovens (round, square, rectangular) and deciding which is most efficient
- *Time, Measurement, and Money:* Using highway maps to plan a trip 300 miles (483 kilometres) from home (vary distance), determining how long it will take driving 55 mph (88 kph) versus flying time, versus covered wagon, versus horseback; setting up a grocery store in class, bringing in items to be used in the store, shopping with monopoly money, tallying up the bill and counting out correct change, then comparing how these activities are done in supermarkets today
- *Fractions:* Writing fraction word problems, putting them on a computer, making a printout, and exchanging with classmates

Fourth Grade

- *Review Addition and Subtraction Facts*: Using computer to write addition and subtraction word problems, exchanging them with classmates to solve; playing "Four-Way Basic Fact" race, participating on one of four teams, one using computers, one using calculators, one using pencil and paper, and one using an abacus to solve 20 basic facts, discovering which team solves all with 100 percent accuracy first

- *Multiplication Facts*: Using Popsicle sticks or tongue depressors to construct a pencil holder having equal numbers on each side (e.g., If four sticks on each side, how many needed? If five sticks, how many?); using basic multiplication fact sheets and calculators to find answers, race against a classmate to find out who finishes first
- *Division Facts:* With the following materials, 5-gallon (19-litre) bucket, one large toy dump truck and sandbox with sand, calculating/estimating how many truckloads it will take to move one bucket of sand; comparing and measuring standards and modes of transportation at a sand and gravel pit; cutting and bringing flowers from a garden, distributing flowers evenly among individual vases; experimenting with assembly line methods and individual assembly methods
- *Time, Measurement, and Money:* Pretending to purchase a meal from an actual menu, using calculator to total costs of all meals; discussing number of children who have paper routes, discussing what time they get up in order to deliver all papers, discussing what mode of transportation they use, solving time/delivery problems in class, testing paper route delivery times
- *Geometry:* Making models of robots using only geometric shapes; constructing a mobile using geometric shapes with closed surfaces, open surfaces, or both, by hanging the forms with a thread from a piece of cardboard, wire, or wood

Third Grade

- *Numbers and Numeration:* Bringing in items that use Roman numerals (clocks, books), comparing Roman numerals to standard numbers today, constructing large clay Roman numerals, practicing making number sentences and solving them; choosing a month and constructing a symbol (using tagboard, stickers, small objects, magazines, cutouts) for the current year, displaying and comparing to calendars of ancient times; discussing how calendars were once made and how they are mass-produced today
- *Addition of Whole Numbers:* Bringing in an airplane model and constructing it, listing the cost of each model and how much the class spent on airplane models; bringing in a shoe box to plant three or four bean seeds, charting daily growth, dividing with others into three groups (one group giving seeds water only, one group using commercial fertilizer and water, the third group using organic soil conditioner and water), totaling the number of inches each plant has grown at the end of three weeks, doing a total for each group and determining which group's plants grew the most
- *Subtraction of Whole Numbers:* Studying population growth by making a chart and finding the differences in populations from 1984 to 1985, discussing why populations change from year to year

in major cities; constructing paper airplanes and flying them, charting the distance each plane went, calculating how much farther the farthest plane went, generating problems computing different distances

- *Multiplication of Whole Numbers:* By means of school ditto and photocopy machines, generating multiplication problems (e.g., If the machine runs 20 dittos in one minute, how many will it run in five minutes?), solving by hands-on experience with machines, writing multiplication story problems on computer and printing out, sharing problems with the class as "teacher for the day"

Second Grade

- *Number and Numeration Meanings:* Discussing how crayons, pencils, and paint brushes are bundled into groups for shipment to schools (e.g., How many per box, does a large company such as Crayola count each box by hand or use a machine?), bundling in groups of ten pencils or paintbrushes
- *Patterning:* Discussing patterns seen in daily life (e.g., floor patterns, fabric patterns), using yarn and a handmade cardboard loom to weave a color pattern (e.g., ABAB or ABCABC pattern)
- *Addition of Whole Numbers:* Putting a large number of punch-out or real coins of different denominations in a bag, taking a handful, arranging coins in order of value from greatest to least and determining their value; putting money from a piggy bank into a bag, going on a field trip to a local bank and observing how machines are used to count coins; putting up a weather chart in the classroom, reporting the weather and charting on graph, tallying and putting up results on a bar graph at the end of the month
- *Subtraction of Whole Numbers:* Role-playing as clerks and customers at a mail order store, choosing items for purchase from a catalog, placing an order, checking orders with a calculator

First Grade

- *Recognizing Numbers and Numerals:* Touring the school and locating machines that use numbers; using "task cards" at the school's typewriter center and following directions on the card (e.g., type five #1s or six #2s)
- *Basic Addition Facts and Properties:* Answering 25 basic fact questions on the computer (preprogrammed) and printing them out; dividing into two teams, one team using calculators, one team using pencil and paper, to solve 15 basic addition fact problems and deciding which team is more accurate and which finishes first
- *Basic Subtraction Facts and Properties:* Dividing into two teams, one team using calculators, one team using pencil and paper, to solve 15 basic subtraction fact problems and deciding which team is more accurate and which finishes first
- *Skip Counting:* Discussing how factories bundle large quantities of merchandise in assembly lines; participating on one of four teams, each with a bag of pretzel sticks, and in assembly-line fashion, skip counting by 2s, 5s, and 10s, bundling them; visiting local bakery to follow up

Kindergarten

- *Position, Classification, and Patterning:* Recording with a tape recorder different hand-clapping and finger-snapping patterns; bringing in old keys from home and sorting them by various characteristics, discussing where the keys might have come from, what they were used for, and why we need keys; bringing in various carpet scraps and scarves, and discussing the patterns on these items, such as stripes and repeating patterns; making a cardboard and string loom and creating a repeating weaving pattern
- *Recognizing and Counting Numbers, 0–20:* Practicing the counting sequence, using a weight tied to a length of string to form a pendulum, counting along with it as it swings freely, stopping and restarting the pendulum motion at the end of each counting sequence, finally letting the pendulum swing freely without stopping it, discussing what types of things have pendulums and why; dropping appropriate numbers of objects through the slit in a milk carton while counting out loud, guessing how many objects there will be when the milk carton is lifted up; discussing why counting is important; going on a field trip to a bank to see how they count money
- *Geometric Shapes:* Walking around the classroom, school building, or surrounding neighborhood looking for square shapes, discovering squares in overhead light fixtures, window panes, doors, ceramic tile floors; constructing a "shoe box room" incorporating square objects; identifying various geometric shapes while using a computer graphics program, doing a computer printout of the shapes identified
- *Measurement:* Collecting measuring devices such as rulers, yardsticks, tape measures, measuring things in the classroom, measuring each other, deciding which form of measurement is most accurate, discussing how large things are measured; collecting dry measurement devices such as spoons, measuring cups, paper cups, working in a measuring center with sand and water, guessing how much certain containers will hold, visiting the school cafeteria to see measurements being made on a larger scale

Instructional Strategies for Science

The student should understand relationships between science principles and technological systems.

Integrating technology and science skills within the common education core includes examples such as the following:

Fifth Grade

- *Plants and Animals of Long Ago:* Creating jewelry, using forest materials such as cones, feathers, animal bones, seeds or nuts, and writing a legend that describes the significance of this piece of jewelry in an imaginary culture; using clay to make a model of a dinosaur and exhibiting it in its natural environment; weaving a reed basket and comparing it to baskets made by modern methods

- *Geology:* Using various materials to grow crystals; discussing how crystals are found in nature and the uses of crystals; building a model of a river to demonstrate erosion; discussing the dynamics of moving water and the resultant changes on earth; building a model that shows how rocks absorbing water change their shape and break down
- *Human Biology:* Experimenting with an electroencephalograph and an electrocardiograph, creating a poster of one of the machines, and including facts about its use today; creating a collage for one or more of the following careers, including words describing the career: optometrist, orthopedist, pediatrician, psychiatrist, psychologist, urologist; maintaining a journal of current articles about nutrition and its effects on the human body
- *Light Properties:* Constructing a periscope to demonstrate reflection; constructing a pinhole camera to demonstrate how light rays travel; constructing a smoke box to demonstrate how light travels
- *Ecosystems:* Creating a board game of a pond ecosystem to understand the concept of balanced systems; recreating habitats observed by making terrariums; reading *A Letter from Archy*, by Don Marquis; discussing how natural resources relate to jobs in a community; and going on field trips to various job sites

Fourth Grade

- *Life Cycles:* Visiting a fish hatchery and studying fish life cycles; learning how controlled production of fish helps the food economy; gathering silkworms and raising them in the classroom, observing their growth and development, and discussing production of silk today; constructing a food pyramid (chain) mobile to observe its complexity and relationship to personal, physical maintenance
- *Electric Light Circuits:* Constructing a working doorbell to study electrical currents; setting up an electric circuit and testing materials to see which will conduct electricity; constructing a telegraph sounder to communicate with a friend at a distance
- *Solar System:* Constructing a solar oven, cooking foods and comparing the efficiency of different oven designs; making a model/mobile of the solar system; constructing a model of the moon to study its path
- *Cells, Tissues, and Your Body:* Constructing cell models and observing the reactions of cells when placed in different solutions; preparing a scrapbook of clippings from newspapers or magazines concerning the body, watching for new technology about organ transplants, bone banks, skin banks, and the like; investigating hazards to the human body posed by space travel or underwater exploration and designing a warning poster to alert people to such hazards
- *Vibrations and Sound:* Constructing a tin-can banjo and predicting sound pitch, comparing it with a manufactured banjo; constructing a vibrating column, noting the principle that the longer the column of air set in vibration, the lower the pitch; constructing a rubber-band banjo and comparing it with the tin-can banjo and the com-

mercial banjo; using pop bottles filled with water at different levels to participate in a pop bottle band

Third Grade

- *Properties of Air:* Producing oxygen, using a flask, glass tube, and rubber stopper (production of oxygen and its importance in space travel); constructing a submarine to show air pressure, hypothesizing how a submarine submerges and surfaces; studying air pressure, using water, cardboard, and a glass
- *Bones and Muscles:* Using a bathroom scale to identify muscle strength; discussing other technological ways to measure strength; discussing the technology of glue-making (from horse bones), making glue; taking a tour of a hospital, seeing X-rays of bones in different stages of development; comparing how broken bones or pulled muscles were identified 100 years ago versus today
- *Heat and Temperature:* Experimenting with colored paper and heat absorption and relating the results to black solar panels used on houses today; using sand, color, and heat from sun or heat lamp, recording different temperatures; discussing the effects of clothing colors in different weather; demonstrating air pressure versus temperature; learning that as water temperature changes, water level changes accordingly
- *Communities of Living Things:* Listing the various foods people eat; discussing the importance of forest and other plant communities as a source of food for humans and animals; visiting a grocery store and, upon return, making a chart or graph of the foods derived from forest plants or collecting food labels and categorizing them into plant communities; collecting bugs to study in a classroom community; setting up a plant terrarium in a tank or glass jar, adding aphids and ladybugs (ladybugs will eat aphids, which destroy plants); discussing and relating natural insecticides used in farming today

Second Grade

- *Moving Things Have Energy:* Constructing a model of a screw to demonstrate how a screw is a simple machine that can multiply a force; constructing a "spool machine" and studying its movement; constructing a windmill; constructing a solar windmill and observing its movement, noting how weather affects its movement
- *Three States of Matter:* Heating water in a teakettle and watching water change to steam; predicting the time it will take for ice cubes to melt; peeling an orange or opening containers of perfume, pickles, and shaving lotion and identifying these items by odor; identifying natural resources from which home building materials are derived and constructing models
- *Plants and Seeds:* Experimenting with bean seeds to see how food is stored in each seed; displaying names of forest-related careers and obtaining pictures for a bulletin board display; and visiting a sawmill, nursery, or other job site involving plants

- *Waste Management:* Demonstrating how water can be purified, using water filters; making glue and testing its effectiveness, studying how glue is made today; taking a field trip to a waste management plant

First Grade

- *Plant and Animal Needs:* Experimenting with one plant in the shade and one in the sunlight, charting their growth, relating the results to agriculture and weather to see that some areas are naturally better for growing; creating an ant farm and observing the needs of ants and how they work together; attaching patches of cardboard to several leaves of a plant, removing the cardboard after four days, observing the changes and learning the importance of not blocking the sunlight from plants
- *Time Measurement:* Discussing concepts of "near" and "far," using a magnifying glass, telescope, and the naked eye to observe objects; measuring different objects with hand measuring tools such as rulers and string and determining which are more accurate; discussing other ways of measuring objects
- *How Things Move:* Observing and comparing the speed of objects on a rough surface, using small toy cars, recording and charting results, and relating the results to highway pavement; visiting a safety center, a department of transportation, or an airport, to discuss how things move and the ways of measuring speed (e.g., radar)
- *Soil and Air:* Collecting samples of soil (e.g., gravel, clay), planting seeds in these different soils and charting growth; discussing natural soil and its suitability for farming; planting seedlings or fast-growing beans in "milk carton" pots (four beans in each pot), treating some with fertilizer in varying amounts, observing their growth, and relating it to the use of fertilizers today; discussing ways of predicting weather and its effect on plants to ensure successful growth

Kindergarten

- *Describing Objects:* Working in learning centers, using the five senses to describe human-made versus natural objects; taking part in a five-senses "show and tell"
- *Time Intervals:* Filling jars with different liquids: honey, water, corn syrup, and so on, dropping a marble into each jar and observing the movement of the marbles, noting which are fast and which are slow, and comparing them with other things that move fast and slow; constructing a lima bean garden using cotton and water, observing daily events, including which seeds sprout first, recording each day's results; talking about planting and farming today
- *Objects and Motion:* Making a simple pulley system, using cord or yarn and draping the cord over a doorknob and testing the pulley system; collecting pictures of machines that drop and lift, such as airplanes, cranes, submarines, and labeling them as to whether they drop, lift, or both; experimenting with the path of a rolling object and a sliding object

- *Properties of Living Versus Nonliving Things:* Identifying one or more living and nonliving things, using only tactile perceptions and a "touch-feel box," making a touch-feel box; collecting items or pictures and categorizing them as "once were alive," "never alive," or "alive," including pictures of lawnmowers and typewriters

Instructional Strategies for History–Social Science

The student should understand relationships between history–social science concepts and technological systems.

Integrating technology and history–social science skills within the common education core includes examples such as the following:

Fifth Grade

- *Becoming a Nation—13 Colonies:* Making time lines of U.S. history; making a class recipe book of colonial foods; working together to prepare a colonial meal; learning to construct a lantern; making soap and testing its effectiveness; comparing traveling by Conestoga wagons to automobiles, Colonial ships to modern shipping
- *Civil War:* Constructing a cotton gin; holding a mock election (Lincoln versus Douglas); researching and reporting on technological advancements in weapons since the Civil War
- *Westward Movement:* Comparing transportation modes of the homesteading farmer in the 1800s to cross-country travel today; dramatizing a tale about one of the following people: Daniel Boone, Davy Crockett, or Johnny Appleseed
- *The United States Grows and Changes:* Listing four inventions in communication since industrialization and constructing one; making a chart of power used to run machines before industrialization and after; studying mass production and how it enables the manufacturer to produce goods quickly and in great quantities; dividing into two teams and, forming an assembly line, producing a tin-can telephone
- *The United States in Today's World:* Clipping newspaper articles to identify slanted versus objective writing; making scrapbooks of newspaper articles that describe life in the past, present, and future; studying the evolution of the automobile; designing an automobile of the future and describing how it works; bringing in model cars to construct in teams as in an assembly line; discussing changes in flight over the past 80 years; looking at a picture of the Wright Brothers' airplane and discussing its design; working in teams to produce a classroom quilt, each square depicting a characteristic of one of the 50 states, embroidering or crayoning the fabric and then machine sewing it to produce a quilt

Fourth Grade

- *Geography of California:* Making a relief map of California, using flour, salt, water, or clay; visiting a 4-H Club, viewing animals, how they are taken care of, where they live in California, and how they help our state's economic growth; predicting the weather (making a chart) and comparing with daily weather reports on television

- *First Californians and Mission Days:* Constructing a model of an Indian village; weaving baskets using clothesline, yarn, and tapestry, comparing to a basket bought in a store and the length of time to produce by hand versus machining; visiting a California mission and comparing the original structure to portions of the mission that have been restored, then assembling, as a class project, a sugar cube mission
- *Gold Rush:* Setting up a mining camp in class, constructing a sawmill, sluice box, cradle, water wheel; comparing how gold was mined in early days versus today; making models of early covered wagons, discussing the three routes the forty-niners took to reach California and how long it took, comparing how long it would take today, using a car, plane, or boat
- *California in the New Century:* Comparing and constructing Indian housing of yesterday versus Indian reservation housing today; exploring and researching the fishing laws in California, answering questions such as are there fishing seasons, are there limits on the numbers of fish that can be caught?

Third Grade

- *Learning About Communities:* Drawing a map of the classroom, labeling cardinal directions, and making a key, working either individually or in small groups; making a model of the school grounds and labeling important school locations, including arrows directing students to fire drill exits; taking a field trip to a major business in the school's community and discussing how a business helps support the community; bringing tools from professions and trades such as dentistry, law enforcement, carpentry, and having a hands-on exercise or career day, sharing the tools and their uses
- *Living in Different Communities:* Making transportation collages or models, including systems that use monorails, cable cars, buses, airplanes, trains; bringing a copy of a bus schedule and comparing it with computerized airline schedules; constructing two models of a town, the first showing the town soon after it was founded and the second showing the town as it appears today
- *Farms Support Our Community:* Comparing crop growth of a classroom garden, using modern methods (fertilizers, vitamins, pest repellents) versus a garden without modern technological aids; splitting into two teams to make butter, one team using a food processor and one using hand power to churn the butter, comparing work time, taste and texture of butter made by both methods; splitting into two teams to make ice cream, one team using an electric ice cream maker and one using a hand-cranked machine, comparing work time, taste, and texture of the two methods; constructing a greenhouse, using straws, plastic wrap, and other similar materials, then comparing plant growth in the greenhouse with growth outside it

- *Citizenship in the United States:* Campaigning in front of a video camera for viewing by the entire class; holding elections (primary and general), tallying votes and all campaign data by computer; comparing past, present, and future communication; constructing tin-can telephones, then comparing communication by word-of-mouth chain with direct-line tin-can telephone; discussing telephone systems today and inventing a telephone of the future; visiting the telephone company to view the modern equipment that drives our telephone system and requires fewer operators thanks to computerized systems

Second Grade

- *Where We Work:* Bringing in materials used by carpenters, tailors, clerical workers (e.g., hammer, nails, wood, needle, thread, school typewriter, computer), choosing one of these occupations and making a product, using these materials; making a hand-dipped candle and comparing the hand-dipped method to how candles are made today; constructing a model of a dairy farm (plastic animals) and inviting parents to visit the classroom farm; baking bread and making butter to serve to parents when visiting the classroom farm; mixing ingredients to bake bread manually and with an electric mixer, and comparing the results
- *Communities Make Rules:* Making a model of Washington D.C., using boxes of various sizes and making printed street signs to show directions and city rules; comparing hand signals to electronic signals and discussing which are more efficient; writing classroom rules on the computer, printing and displaying them on the bulletin board; writing school safety rules, drawing appropriate pictures, and creating a computer graphic program to print rules to display around classroom and school
- *Communities Long Ago and Today:* Bringing modern toys to class, constructing toys of long ago, using wood, string, sticks, and comparing the two; comparing candlelight and flashlight illumination, making hand-dipped candles for the comparison; using clay adobe bricks made in class to construct an Indian pueblo and comparing it to high-rise apartments of today
- *Celebrating Holidays Around Us:* Using computer graphics to make cards for all holidays; preparing foods from different countries to celebrate holidays; participating on an assembly line to create classroom decorations for each holiday celebration

First Grade

- *Alike and Different:* Using various materials in an assembly-line style to design a car for the production of a train; creating a self-portrait with large tapestry needle and yarn, then discussing how portraits are alike and different; planting various seeds (lima beans, radishes, carrots) in small pots, using modern gardening aids (fertilizers, vitamins) on half the plants and only water on the others, and comparing the results
- *Family Needs:* Drying some fruit on a drying rack made from cheesecloth stretched over a frame and some in the oven to com-

pare the results; making a clay and Popsicle-stick model of a home; weaving a basket, using yarn; fashioning a quilt from fabric brought from home

- *Living in Neighborhoods in the United States:* Making a table model of a neighborhood, labeling streets and showing directions, houses, stores; setting up a mini-post office in the classroom and delivering mail; studying restaurants in the neighborhood, planning and serving a meal restaurant style

Kindergarten

- *About Me:* Participating in a Five Senses Month, preparing different foods to compare smells and tastes, making clay sculptures, making musical instruments, collecting items with different textures; creating a self-portrait, using computer graphics; constructing a mobile, using magazine pictures to illustrate different feelings; constructing puppets to dramatize emotions and feelings
- *Family and Family Needs:* Constructing puppets of family members, having parents help assemble; preparing two meals, using an electric hand mixer to prepare one and manually mixing the second, and comparing the time of preparation; taking a field trip to a restaurant or grocery store to see how food is prepared
- *The Community Around the School:* Constructing a graph showing the modes of transportation classmates use; constructing models of cars, buses, and tricycles; walking through the neighborhood to observe homes and discussing differences between single-family dwellings, multi-family homes, building materials, new homes versus old homes; developing a "milk carton community," decorating milk cartons as houses and apartments
- *Tools:* Completing a finger-painting activity and a brush-and-roller activity, noting differences, and discussing painting tools; making one batch of cookies by hand and another with electric mixers, comparing cookie results and preparation time; making a mobile of tools used in daily life from magazine or catalog pictures

Standards for industrial and technology education explorations define a broad-based program that provides the middle-grade student with an integrated common education core. The standards play a central role in teaching and reinforcing academic core content and skills, expand the student's employability and career awareness, and promote the individual's level of technical competence.

The student of industrial and technology education explorations becomes familiar with historical, current, and potential developments in industry and technology, as well as the effects of such developments on consumers and members of society. As a result of participation in industrial and technology education explorations, the student entering high school will be able to make informed career/occupational/educational decisions based on the knowledge and skills acquired and according to personal interests and aptitudes.

The industrial and technology education exploration standards encompass career guidance; construction technology; communications technology; manufacturing technology; materials; power, energy, and transportation technology; and tools and machines. The students' acquisition of new knowledge, developing awareness of individual interests and abilities, and application and transfer of skills learned in other disciplines are the fundamental goals of this program.

Educators should refer to the Program Framework section of this document for a discussion of the broad conceptual components and specific elements guiding the development of the standards listed herein.

Contents

1. Career Guidance in Technology

Career guidance in exploring industrial and technology education is an essential component in a systematic and articulated career-planning program, providing students with self-appraisal activities, an understanding of career clusters, and career development based on transferable skills.

Standard ***The student will understand a variety of technology career clusters and develop an awareneww of career development based on transferable skills.***

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2. Construction Technology

Construction technology is a diverse, complex field that meets the equally diverse and complex needs of a technological society.

Standard ***The student will describe the historical and potential role of construction technology in the United States. The student will identify major components of construction technology.***

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3. Construction Techniques

Construction techniques include those systems, processes, and materials incorporated in the development of structures to meet human needs. Understanding the relationship of such techniques to the total construction process requires a review of the role that construction holds in society and knowledge of five basic types of construction.

Standard ***The student will identify five types of construction, explain three steps in the construction process, and describe the role construction has played in the development of the United States.***

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4. Construction Management

Construction management involves planning, organizing, and controlling all phases of construction and is central to the study of the construction industry.

Standard ***The student will explain the role of planning, organizing, and controlling construction activities, list the steps in construction planning, read and identify different types of construction prints, and discuss the importance of management in the construction process.***

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5. Preparation for Construction

Preparations for construction activities include community planning, surveying, and site preparation.

Standard ***The student will list three steps required in preparing for construction, explain the use of surveying and mapping, use surveying tools and procedures in surveying activities, and discuss the importance of community planning and site preparation.***

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6. Communications Technology

Communications technology is a highly complex and sophisticated mix of processes and systems that affects all levels of society.

6. Communications Technology (Continued)	*Standard The student will understand several communication processes and their importance in the total communications system. The student will understand how the total communications system affects society. The student will define communications and identify forms of verbal and nonverbal communications.*
7. Computer-Based Communication Systems	Four types of human-machine communication systems incorporating computers are computer-aided design, computer-aided engineering, computer-aided drafting, and computer-aided robotics. *Standard The student will explain four types of computer-based communications systems. The student will discuss how machines and people communicate and explain the role of computers in communications systems.*
8. Audio Communications	Sound waves, electricity, and light are used to transmit information, using audio devices common in everyday experience. An understanding of how audio signals are transmitted and received is fundamental to the study of communications technology. *Standard The student will understand how sound is transmitted via telegraph, telephone, radio, tape recorder, and stereo systems. The student will understand sonar, laser light, and fiber optic-transmitted sound.*
9. Visual Communications	The study of symbols, symbol conventions, visual design, printing techniques, photography, holography, drafting, and similar forms of nonverbal communication is essential in a society dependent on visual representations. An understanding of visual communications systems provides for the development, control, and application of visual information. *Standard The student will explain the use of symbols in visual communications. The student will understand the design-analysis method of graphic design and will be able to identify various printing methods. The student will complete a sequence of drafting exercises, including sketching, design, orthographic projection, and pictorial drawings. The student will understand the importance of nonverbal communication.*
10. Computer-Aided Drafting	Highly developed computer systems make it possible to create, control, and relay design information. Familiarity with these systems as informational and procedural tools is important in carrying out certain occupational tasks. *Standard The student will explain how the drafting/design-analysis method is used in computer-aided drafting. The student will identify various printing methods and devices that interface with computers.*

11. Telecommunications	Telecommunications, the electronic sending and receiving of information, is the most rapidly expanding communications technology of the 1980s. Students should understand how radio and television communications make it possible to communicate with large audiences in many parts of the world, simultaneously. Space satellites, masers, and lasers are the new technologies of telecommunications industries. *Standard The student will define telecommunications and explain the basic principles of radio and television transmission and reception. The student will examine telecommunications as a recreational, educational, and social force.*
12. New Communication Technology	The future of communications is being shaped by the versatility and capabilities, both current and potential, of the microcomputer and the microprocessor. Communications systems have progressed from magnetic to optical, and from analog to digital. System size and cost have decreased while power and application have correspondingly increased. *Standard The student will compare industrial and personal applications of selected forms of communications technology. The student will understand the relationships of cost, size, power, and application to communications technology developments.*
1 Manufacturing Technology	Understanding how manufacturing enterprises are organized is fundamental to knowing how goods and services are produced and provided in the world economy. The study of the manufacturing system includes an analysis of present and historical relationships to the American economy, organization and ownership formats, employment opportunities, prerequisite skills required of system participants, and the importance of manager-worker interaction. *Standard The student will identify products manufactured through custom and mass production methods. The student will describe how raw materials are processed into finished products through six steps of production. The student will understand how basic economic principles relate to manufacturing. The student will discuss human skills required to operate a manufacturing enterprise.*
14. Manufacturing Organization and Finance	Modern manufacturing practices require a thorough understanding of manufacturing firm organization, capital, and operational principles in order to operate a successful manufacturing enterprise. *Standard The student will define three forms of business ownership, describe how businesses are financed, and read an organizational flow chart. The student will organize and operate a mass production company for profit.*

15. Historical Development of Manufacturing

The industrial revolution dramatically affected how we live today. Understanding how the industrial revolution led to the mass production of products and with engines eliminated the need for human, animal, and water power provides a rationale for socioeconomic shifts. An awareness of technological changes that have taken place in American manufacturing enterprises provides insight into what the future holds for manufacturing industries.

Standard The student will explain three major changes in manufacturing that occurred during the industrial revolution. The student will define reindustrialization. The student will discuss how computer-aided engineering and computer-aided manufacturing will change future production methods.

16. Manufacturing: System and Process

Manufacturing systems incorporate tools, materials, and processes to produce goods. Manufacturing processes are defined by specific steps that provide for the manufacture of goods in mass quantities for consumption. An understanding of manufacturing systems and processes provides insight into diverse career opportunities requiring various levels of education and training.

Standard The student will explain manufacturing as a three-part system with four inputs and six processes. The student will describe distinctions between mass and custom production and define terms, including cost estimation, market research, tooling-up, jigs, fixtures, quality control, reject, production loss, standards, and trial run. The student will gain an awareness of the concept of career development based on transferable skills.

17. Manufacturing and Free Enterprise

Manufacturing activities in the United States operate within a free enterprise system. An understanding of the free enterprise system is essential to a complete appreciation of manufacturing systems, processes, and structure.

Standard The student will understand the free enterprise system and correctly use related terms, including free enterprise, supply and demand, prosperity, recession, depression, productivity, automation, robotics, and standard of living.

18. Materials

The process of converting raw materials into industrial materials and the conversion of both raw and industrial materials into finished products is fundamental to industry and technology. Understanding material sources and physical properties and how materials are processed into useful goods is basic to an understanding of industrial systems.

Standard The student will understand the fundamentals of processing raw and industrial materials into finished goods.

19. Material Processing	Material processing, with the purpose of conversion into useful goods, follows a structured sequence, typically involving preprocessing, processing, and postprocessing. In order to understand the conversion of raw and industrial materials into useful products, producers and consumers must understand the sequential elements of material processing. Standard *The student will understand and explain a basic three-step material-processing sequence. The student will understand related industrial material processes: forming, shaping, and joining.*
20. Plastic and Composite Technology	The rapidly expanding variety of synthetic materials, their applications, and the corresponding growth of related industries demands an understanding of synthetic materials' chemical and physical characteristics and production and processing techniques. Standard *The student will explain the difference between thermoplastic and thermosetting synthetics and explain how they may be produced and manufactured into useful goods. The student will understand synthetic application criteria, perform calculations required of a specific synthetic product, and construct the product, employing a variety of tools, machines, and fabrication techniques.*
21. Metal Technology	Consumers and producers of metals and metal products must understand material characteristics and production techniques involved in metal industries. Standard *By participating in metal fabrication activities involving appropriate tools, machines, and techniques, the student will understand metalworking techniques, identify and describe characteristics of commonly used metals, and understand a variety of career opportunities in metal technology.*
22. Wood Technology	Consumers and producers of wood and wood products must understand the material characteristics and production techniques involved in the wood industry. Wood properties—durability, warmth, beauty, strength, and ease of shaping—provide for uncommon career, avocational, and aesthetic expression opportunities. Standard *By participating in wood fabrication activities involving appropriate tools, machines, and techniques, the student will understand woodworking techniques, identify and describe characteristics of commonly used woods, and learn about a variety of career opportunities in wood technology.*
23. Power, Energy, and Transportation Technology	Power, energy, and transportation technologies fulfill a prominent role in the growth and development of social, cultural, and technological systems.

23. Power, Energy, and Transportation Technology *(continued)*	*Standard The student will understand how developments in land, water, air, and space travel influence our social, cultural, and technological systems. The student will understand power and energy concepts, including source depletion and alternatives. The student will define energy, power, and force. The student will explain potential and kinetic energy.*
24. Air/Space Transportation	Explorations into space have resulted in the development of new materials and systems. *Standard The student will understand and appreciate the existing and potential variety of air/space vehicles. The student will understand fundamentals of air/space vehicle designs and power sources.*
25. Land Transportation	The quotation, "America runs on wheels," expresses a dependency on automobiles, trucks, and trains. With this dependency, it is important to understand how the predominant land transportation system developed and what role it plays in technological society. *Standard The student will understand the development of the complex interstate road system and the relationships of major road and rail links to our economic society. The student will understand the concept of interstate commerce and transportation of goods.*
26. Water Transportation	Waterways have long served humankind as an inexpensive and easy means for moving goods and people. Water transportation still plays a vital role in world commerce, national defense, and recreation. *Standard The student will explain how water transport has moved and continues to move people and goods by various water vehicle designs.*
27. Energy Sources	The technological world is dependent on the burning of polluting, nonrenewable fossil fuels. Recognizing this dependence, it is important to understand issues related to the consumption of fossil fuels and to be aware of alternative energy sources. *Standard The student will identify major sources of energy now in use, their effects on the environment, and the alternative energy sources available or under development. The student will also gain an appreciation for energy conservation.*
28. Energy Conversion	The conversion of energy from one form to another is a fundamental process that provides electricity, powers mechanical engines, and performs other mechanical functions. *Standard The student will understand hydraulic, solar, and wind-generated electrical power. The student will understand the operational principles of reciprocating and rocket engines.*

29. Power and Energy Transmission

Once energy is converted into a usable form, it must be transmitted in order to provide power to perform useful work. This concept of energy transmission is necessary to the understanding of how electrical and mechanical energy are delivered to provide usable power.

Standard The student will understand how electrical power is transmitted. The student will describe four parts of a mechanical transmission and three types of mechanical power. The student will explain the difference between hydraulic and pneumatic power.

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30. Simple Machines

The principles of simple machines can be used to convert energy into usable power.

Standard The student will describe six simple machines and discuss how the principles of simple machines are used to convert, transfer, and change energy into usable or desirable power.

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31. Electricity-Electronics

Technological advances are predicated on developments made in the field of electronics, electrical power, and the transmission of information.

Standard The student will describe the difference between AC and DC current. The student will identify simple electronic components, explain their use, and construct simple electronic circuits from identified components. The student will understand basic electronic theory as it relates to current, voltage, and resistance.

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32. Tools and Machines

The proper and safe use of tools and machines in the forming, shaping, and fabricating of materials is integral to the study of technology. The understanding of how to use machines correctly and safely in specific applications is essential.

Standard The student will identify and use common hand tools and specific machines in a safe and proper manner. The habits and skills acquired by the student will be practiced and carried over to future environments where tools and machines are present.

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33. Career Guidance

A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering.

Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; selecting the program that meets their career-vocational preparation goals; and expanding their individual options.

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34. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is the ability to adapt to the changing attitudes and trends that are affecting the lives of all students today. Standard *All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
35. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of industrial and technology education courses and programs. Leadership development shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society. Standard *Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the use of the democratic process.*
36. Safety	All students will be aware of potential hazards, safety rules and regulations, and effective ways of handling accidents as they occur. Standard *The student will have a thorough knowledge of skills and attitudes concerning the safe use of tools, machines, materials, and processes and will demonstrate this understanding at all times.*

Industrial and technology education explorations standards integrate academic core skills, including:

Language Arts

- Developing oral skills by making presentations and participating in discussions
- Expanding writing skills by making and submitting reports
- Studying and learning vocabulary in context
- Increasing reading comprehension skills
- Developing listening skills during lectures and discussions
- Using critical-thinking skills to analyze and apply industrial and technology education concepts
- Interpreting and analyzing visual information
- Learning the use of a technical dictionary

Mathematics

- Reading and interpreting charts and graphs
- Employing a variety of measuring instruments
- Performing calculations
- Solving problems of quality control and product cost
- Studying production/time concepts
- Computing expenses and costs
- Interpreting schematic diagrams
- Reading and interpreting scales, gauges, and settings

Science

- Investigating emerging electronic and optical methods of audio communication
- Investigating magnetic forces and electrical currents
- Studying the nature and role of heat and electricity in technological applications
- Identifying examples of elements and alloys by means of their physical properties
- Understanding that energy appears in many forms and is defined as the ability to do work
- Studying basic concepts, including lift, drag, mass, weight, time, and velocity
- Understanding applications of the inclined plane, lever, gears, and pulley systems in the design of tools and machines

History–Social Science

- Studying the growth and change of American technology
- Learning that expeditions into space have provided useful information and materials
- Studying the influence of entrepreneurs and inventors on technology
- Learning that the economic and social growth in society has resulted from a highly sophisticated communications technology
- Studying the evolution of characters or symbols from early hieroglyphics to computer representations

- Investigating the relationship of visual communication technology to the life of the individual
- Studying the development of computer-aided design
- Exploring the development of visual communications systems from silent black and white movies to electronic color reception (television)
- Appreciating the social, cultural, and economic impact of land transportation systems
- Studying the development and socioeconomic impact of water transportation systems

Visual and Performing Arts

- Appreciating the impact of graphic displays and use of color via electronic design
- Developing and refining the skills, knowledge, and understanding necessary to make aesthetic judgments
- Engaging in creative activities that help to develop personal insight
- Understanding design as it applies to aerodynamic forces of friction and resistance in transportation vehicles

Standards for industrial and technology education specializations are distinct components of a technical core designed to span instruction in the comprehensive high school, the regional occupational center/program (ROC/P), adult education, and California colleges and universities.

The specializations develop from integrated components of technology within the second administrative level of the model framework—industrial and technology education explorations. These specializations emerge in seven distinct curriculum clusters: construction technology; diversified occupations; electronics technology; manufacturing technology; power, energy, and transportation technology; visual communications technology: drafting; and visual communications technology: graphics.

As students proceed through industrial and technology education specializations, alternatives are provided, with the assurance that the paths they choose are directly related to their career, personal, and social goals; that bridges exist to help students move from one path to another as they mature and develop through their high school years; and that students are able to take the necessary prerequisite courses for their chosen paths.

In early high school offerings, industrial and technology education specialization standards support programs that address a specific cluster, are broadly designed in curricular scope, and are integrated within the common education core to provide for the general education of all students. Occupationally specific and trade and industrial standards for third- and fourth-year comprehensive high school-aged and postsecondary or adult students are likewise found in industrial and technology specializations cluster areas. Specializations at this level are specific to one of the seven cluster areas described and integrated with the academic core.

Students whose career goals include employment immediately after high school as well as students who plan to continue their formal education beyond high school enjoy access to industrial and technology education specializations programs.

Model standards for each of the seven cluster areas are listed individually in the following seven sections of the document.

Educators should refer to the Program Framework section of this document for a discussion of the broad conceptual components and specific elements guiding the development of the standards included herein.

Construction Technology

Construction technology standards focus on general construction technology, cabinet-mill technology, furniture technology, building trades, heavy equipment, pattern-making, boat building, and entrepreneurship. The student's acquisition of new knowledge, development of awareness of individual interests and abilities, and application and transfer of skills learned in other disciplines are fundamental concepts in this cluster.

The student of construction technology becomes familiar with historical, current, and potential developments in industry and technology, as well as the effects of such developments on consumers and members of society. As a result of participation in construction technology, the student will be able to make informed career/occupational (educational) decisions based on the knowledge and skills acquired and according to personal interests and aptitudes.

Contents

33. Construction Estimating
34. Materials
35. Zone/Code
36. Mapping/Surveying
37. Level/Transit
38. Foundations/Floors
39. Walls/Partitions
40. Roof Framing Systems
41. Welding
42. Roofing
43. Electrical Wiring
44. Interior and Exterior Finishes
45. Floor Covering
46. Metal Construction
47. Heating/Cooling
48. Plumbing
49. Masonry/Concrete
50. Insulation
51. Glazing
52. Building Maintenance
53. Landscape Design
54. Hoisting/Cranes
55. Earth-Moving Equipment
56. Ditching/Trenching
57. Pump Operation
58. Compressor Operation
59. Foundry
60. Plaster/Trim Mold
61. Fiberglass Mold Development
62. Boat Building
63. Residential Management
64. Commercial Construction Management
65. Stage Technology
66. Career Guidance
67. Gender Equity
68. Leadership

1. Orientation	A student needs to know what is expected in order to work effectively in the classroom and, in turn, to understand what will be learned in the program. *Standard The student will know and understand classroom procedures.*
2. Safety	In construction, the single most expensive aspect of business technology of concern to employers, other than wages, is worker safety. Cal-OSHA claims and related legal expenses can be very costly; therefore, thorough safety instruction is required of all workers. *Standard The student will have a thorough understanding of all aspects of safety operations and instructions involving the commercial and residential construction industry.*
3. Planning Design	Design or design selection is basic to the production of a quality product so that it can be produced economically, be functional, and fit into the environment in which it will be used. *Standard The student will develop aesthetically pleasing products designed for ease of fabrication.*
4. Hand Tools	Proper selection and use of common hand tools is necessary for successful wood construction. *Standard The student will be proficient in the safe use and care of basic hand woodworking tools.*
5. Portable Power Tools	Knowledge of the safe and skillful use of portable power tools is necessary to successful wood construction. *Standard The student will be skilled in the safe use of portable power tools in the construction area*
6. Machine Use	Machine tool skills are essential for any trade in construction technology. *Standard The student will be able to select and safely operate specific machine tools needed to complete a task*
7. Measurement/Layout	An essential element of quality product development and production is the proper reading of plan measurements and the conversion of this information to rough and finished measurements. *Standard The student will be proficient in the reading of a rule to 1/16 of an inch (1 6 mm) He/she will be able to transfer the measurements from the plan to the project and to apply proper layout procedures*

8. Joints

A critical aspect of quality product fabrication is the proper design and construction of joints.

Standard ***The student will be able to identify and construct the basic wood joints used in the applicable construction trades.***

9. Gluing and Clamping

An essential element of quality product production is the proper understanding of gluing and clamping procedures.

Standard ***The student will be proficient in the selection and application of the proper glue(s) and clamps necessary in the joining of materials for an aesthetically pleasing and structurally sound product.***

10. Fasteners/Hardware

The appearance and function of a quality product can be determined by the proper selection and installation of fasteners and hardware.

Standard ***The student will be proficient in the selection and installation of the proper fasteners and hardware to be used on the product being fabricated.***

11. Abrasives

The use of abrasives, particularly abrasive papers for preparing finished surfaces, has been common in construction technology throughout the ages. In recent years, synthetic abrasives, which are faster, stronger, sharper, and generally better than natural abrasives, have been developed. As a result, the use of abrasives has been extended to cutting and shaping functions.

Standard ***The student will know the varieties and characteristics of abrasives and be skilled in their selection and application.***

12. Finishes and Coatings

Finishing is an important function in construction technology because finishes protect the surfaces of the constructed products from discoloration and deterioration by the elements and enhance the beauty and general appearance of the products. The types and varieties of finishes and coatings used in construction technology range from the fine varnishes and lacquers used on furniture to common house paint used in building construction, fencing, and pilings. The application of finishes and coatings is part of almost all crafts within construction technology to the point of constituting a separate craft unto itself, i.e., painting and decorating. Almost all products of construction technology receive some kind of protective coating or finish.

Standard ***The student will have knowledge and skill in the selection and application of finishes and coatings appropriate to the construction project being finished***

13. Materials	A study of materials is essential to the understanding of wood products and related industries. Standard *The student will understand the manufacturing techniques used with lumber and in the lumber products industry and will identify, select, and use appropriate materials.*
14. Mass Production	The mass production process is of paramount importance in a highly technological society. Standard *The student will have an understanding of the principles of mass production and the impact it has on the lives of people in the world today*
15. European System	The European system of cabinetry is new to the United States and is an emerging concept in the cabinet industry. Standard *The student will understand how European cabinetry is constructed and will be familiar with the materials and hardware used in this style*
16. Plastic Laminate	Plastic laminates are an essential part of the cabinet industry. Standard *The student will understand the process of laminating plastic as applied to the cabinet industry*
17. Cabinet Estimating	Accurate estimation of job costs is essential for the livelihood of the cabinetmaker. Standard *The student will develop the skills necessary to estimate the job costs of cabinetmaking*
18. Print Reading	Print reading is the visual language of the construction industry and is essential to understanding the industry. Standard *The student will comprehend the symbols indicated on a print and will translate this information to the construction of usable items.*
19. Computer Applications	The use of computers in the wood products industry is increasing as technology advances. Standard *The student will use computer programs especially written for the construction industry*

20. Subsystem Assembly

In the construction of any cabinet, it is most important to understand the assembly procedure for face frames, doors, and drawers.

Standard The student will learn to construct face frames and use the appropriate techniques and procedures in the construction of doors and drawers.

21. Hardware

Hardware and its use in the broadest sense allows homes, cabinets, and furniture to become functional.

Standard The student will demonstrate the ability to recognize, select, and install appropriate hardware on wood products.

22. Installation

In cabinetmaking, the ultimate goal is to install the cabinet in the space for which it was built. The appearance of well-crafted sets of cabinets can be marred by poor installation or be enhanced by proper installation.

Standard The student will use appropriate techniques and procedures for installing cabinets and will understand the importance of proper installation

23. Jigs and Fixtures

In the wood product industry, a craftsperson must know how to build jigs and fixtures. These devices enable parts to be duplicated accurately, rapidly, at a low cost, and with safety.

Standard The student will demonstrate a knowledge of jigs and fixtures and their applications, will demonstrate an understanding of the concepts required to construct jigs and fixtures, and will develop a jig or fixture to be used in a production run

24. Millwright

A millwright is responsible for the design and construction of all tooling required in a mill.

Standard The student will develop skills for the design and construction of precision metal jigs and fixtures, as well as the skills needed for making the cutters used in the manufacture of molding, trim, and other wooden products

25. History of Furniture

An essential aspect of furniture production is a proper understanding of the historical changes in furniture-making as a result of necessity, availability of materials, and the development of mass production techniques and suitable designs.

Standard The student will learn to distinguish style, period, and materials used in earlier furniture construction; will understand the impact of design concepts; and will, as a result, be better able to replicate and repair furniture and to appreciate the significance of this work

26. Wood Carving

An essential aspect of furniture-building is the production of a properly proportioned, aesthetically pleasing, thoroughly planned, and carefully made wood carving.

Standard *The student will be proficient in creative design, the techniques of carving, and the selection of specific materials and their grain patterns and characteristics.*

27. Laminating and Bending

The lamination and bending of wood has modern construction applications in the use of glu-lam beams in building construction and heat and steam bending in boat and musical instrument construction.

Standard *The student will understand the three forms of wood bending. The student will employ the use of laminating techniques in a project to increase strength and aesthetic values.*

28. New and Emerging Technology

A necessary aspect of business and of the construction industry is keeping up-to-date with modern methods and materials.

Standard *The student will learn and demonstrate the ability to monitor methods and materials relating to the industry and will successfully incorporate new and emerging technology in planning.*

29. Veneers

Veneering, a common process in both furniture-making and cabinet-making, is one of the oldest forms of the woodworking art.

Standard *The student will identify methods of slicing and matching veneer and will use the appropriate techniques and procedures in applying veneer to an underlay.*

30. Repair and Refinishing

In the aftermarket of furniture construction, repair and refinishing is a necessary activity.

Standard *The student will learn to employ skills and techniques in the disassembly, repair, or remaking of parts; will reassemble and refinish fine furniture, including cane and thrush; and will apply hardware.*

31. Upholstery

Upholstery is a major area of furniture finishing and is an important feature in product marketing.

Standard *The student will understand the use of upholstery in furniture building and will use upholstering techniques effectively.*

32. Inlaying and Marquetry

Inlaying and marquetry are modern forms of surface embellishment often used on furniture and cabinets. Inlaying and marquetry have major historical significance.

[illegible] Paving and Masonry

Standard ***The student will identify, select, and apply appropriate veneer materials, using the proper techniques and tools.***

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53 Construction Estimating

Construction estimating is a skill necessary for the survival of a construction-related business.

Standard ***The student will be capable of determining the types, sizes, and amounts of materials required, as well as estimating the labor and overhead costs involved, in the profitable completion of a project***

[illegible]

Understanding the types, sizes, and properties of construction materials is necessary for their proper application.

Standard ***The student will demonstrate a knowledge and understanding of all common construction materials.***

An understanding of zoning and building code regulations is necessary to ensure that construction techniques match the type, location, and intended use of a given structure.

Standard ***The student will be aware of basic construction codes and the sources of specific code and zone information.***

A knowledge of mapping and surveying is required for the proper placement of structures in relation to existing elements, such as buildings, roads, and property lines and is necessary for correctly locating utilities, roads, sidewalks, property lines, and other site features.

Standard ***The student will properly locate a new building and all related walks, drives, and utilities. The student will represent existing structures, walks, roads, and other site features on a drawing and will indicate the location of the proposed building in relation to existing structures.***

[illegible]

A primary on-site activity at the start of construction involves the use of a level and transit to facilitate quality construction.

Standard ***The student will demonstrate the proper use and understanding of leveling instruments, including use of the level and transit.***

[illegible] Foundations and Floors

Properly built foundations and floors are essential to a quality-built structure.

Standard ***The student will be capable of demonstrating the knowledge and skills necessary to construct foundation forms and floor framing. The student will place and finish the concrete and calculate the materials needed for the project.***

39. Walls/Partitions

A knowledge of basic layout fundamentals, material utilization, and measurement skills is essential to proper wall framing, which is an important part of quality construction.

Standard *The student will lay out wall plates properly and will accurately construct perimeter and partition walls. The student will accurately plumb and line the constructed walls and will demonstrate an adequate working knowledge of the terminology used in planning and constructing walls.*

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40. Roof Framing Systems

Knowledge of the various types of roof structures and styles is essential in designing structures that meet requirements and conditions.

Standard *The student will demonstrate a good working knowledge of roof types, how each type is assembled, and their application. The student will be capable of assembling a cut roof and installing a truss systems roof.*

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41. Welding

With the increasing use of metal structural systems, light metal welding is an essential skill for a versatile carpenter. This knowledge is important for the certification required by union contractors.

Standard *The student will display the skill and knowledge required to produce a strong, high-quality welded bead in several different positions and with several thicknesses of material to the level of certification.*

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42. Roofing

Understanding various roofing materials and their applications is essential to ensure proper installation and satisfactory roofs.

Standard *The student will demonstrate an understanding of roofing materials and their installation so as to be able to produce a good quality, leakproof roof. The student will estimate the total materials needed for a given project, using a given type of roofing.*

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43. Electrical Wiring

A good working knowledge of electricity and electrical wiring is necessary to ensure a functional electrical system within a structure. Careful consideration must be given to the electrical requirements during the construction phase.

Standard *The student will display the planning and organization knowledge and skill necessary to install an electrical system in a given structure.*

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44. Interior and Exterior Finishes

Interior and exterior finishes are the most visible part of a structure, and a poor finish job will mar the best-constructed structure. Thus, a high level of knowledge and skill in the use of finishes is very important.

44. Interior and Exterior Finishes (Continued)

Standard The student will demonstrate a high level of knowledge of the materials needed for finishing and the skill needed to carry out the finishing processes necessary to meet the industry's standards.

45. Floor Covering

A sufficient knowledge of floor covering systems is required by the industry to fulfill all project requirements.

Standard The student will display the skills and knowledge necessary to plan, coordinate, and install a variety of floor covering materials, including carpeting, vinyl sheet, tile, and hardwood.

46. Metal Construction

An understanding of metal stud and other special uses of metal in construction is necessary because metal is being used more extensively in both commercial and residential structures.

Standard The student will display the skills, organization and coordination, and knowledge needed to plan and construct the metal frame of a given structure.

47. Heating/Cooling

This industry provides a stable and expanding job market in a number of areas, such as service and maintenance of residential and commercial heating and cooling units, commercial refrigeration (medium and low temperature), domestic appliance repair, and related industrial applications.

Standard The student will acquire entry-level skills with emphasis on the refrigeration system and components, basic and advanced electricity, motors, controls, gas-fired furnaces (natural and liquid propane), heat pumps, and resistance heating.

48. Plumbing

A good working knowledge of plumbing materials and installation techniques is necessary to produce an effectively functioning plumbing system.

Standard The student will display sufficient knowledge and skill to plan, organize, coordinate, and install an effectively functioning plumbing system, will determine what materials are needed in specific situations, and will demonstrate the proper installation techniques.

49. Masonry/Concrete

Knowledge of masonry and concrete work and the laying of a level foundation or slab is essential to a quality structure.

Standard The student will demonstrate the knowledge and skills necessary to estimate the cost and amount of materials and will install masonry and concrete in an appropriate fashion.

50. Insulation	With the advent of new insulation requirements and rising energy costs, knowledge of how insulation works and is used is very valuable to the construction worker. *Standard The student will display the knowledge and skill necessary to determine successfully the type and quantity of materials needed to install insulation in an appropriate manner. The student will understand how varying forms of insulation work.*
51. Glazing	Knowledge of window types and sizes as well as installation procedures is essential to a good construction worker. *Standard The student will learn to recognize the different types of windows and glass doors and will have the skills to install them in an appropriate manner.*
52. Building Maintenance	The proper maintenance of a building is essential to the stability of property value and the longevity of the structure. *Standard The student will display the skills needed to maintain a structure properly, including those related to plumbing, heating, cooling, wall surfaces, electrical systems, and flooring.*
53. Landscape Design	Good landscape design and maintenance is essential since landscaping and good appearance can enhance the value of property. *Standard The student will acquire the knowledge and skills needed to design and install a functional landscape for the given building.*
54. Hoisting/Cranes	Knowledge of heavy equipment operation and an understanding of proper safety precautions when hoisting or lifting materials must be learned by the operators of heavy equipment. *Standard The student will identify and list the proper industrial uses of the following: cable cranes, hydraulic cranes, bridge cranes, tower gantry cranes, cableways, pile drivers, forklifts, and hoists. The student will describe the operation, inspection, servicing, and basic components of these pieces of heavy equipment and will operate the equipment safely.*
55. Earth-Moving Equipment	Knowledge of the operation of heavy earth-moving equipment is vital in the construction industry since most construction projects begin with the movement of earth to prepare the site. *Standard The student will identify and list the basic components and proper industrial uses of the following earth-moving equipment: graders, bulldozers, scrapers, watering systems, front-end loaders, and compacting equipment. The student will operate, inspect, and service the equipment safely.*

56. Ditching/Trenching

Knowledge of ditching and trenching operations, using heavy equipment, is essential the construction industry since one of the first procedures on a construction site is trenching for foundations and pipes.

Standard The student will identify and list the proper industrial uses of the following ditching and trenching machines: backhoes, graders, pipe-layers (crawler side boom), hydraulic crawler excavators, and paving breakers. The student will learn or learn about the operation, safety procedures, automotive preventive maintenance, servicing, basic components, and hauling as they apply to ditching and trenching vehicles.

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57. Pump Operation

Knowledge of pump operation is vital in the construction industry since pumps are used at different stages during building construction to move liquids such as water, fuels, and wet concrete. The operation of pumps requires a basic understanding of construction procedures, including safety, electricity, and the principles of engines (both gasoline and diesel).

Standard The student will identify the proper industrial uses of the different classifications (centrifugal and others) of pumps and will learn or learn about the operation, safety, servicing, and starting (priming) of pumps.

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58. Compressor Operation

The operation of compressors requires a basic understanding of construction procedures, including safety; electricity; hose fitting; and the operation of motors and engines.

Standard The student will identify and classify industrial compressors and will understand the safe operation, servicing, and starting of compressors.

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59. Foundry

Patternmaking is a primary and integral part of the metal molding process.

Standard The student will become familiar with and trained in the construction of wooden one-piece, split, and core patterns commonly used in the foundry industry.

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60. Plaster/Trim Mold

Plaster trim and molding is an integral feature in the erection of new buildings and reconstruction of older ones. The development of wooden patterns to pull male and female molds is essential to the construction of plaster trim.

Standard The student will design and construct patterns and molds appropriate to the plaster trim and molding industry.

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61. Fiberglass Mold Development	The development of wood plugs and patterns is an important component of the mold-making process, which is a critical part of production in the plastics industry. *Standard The student will manipulate material and develop an understanding of the process of building patterns for pulling rigid and soft plastic molds.*
62. Boat Building	Specific and unique skills are important in the wooden-boat–building industry. *Standard The student will read plans, identify components, and successfully construct water craft of various classes, such as motorboats, rowboats, and sailboats.*
63. Residential Management	Critical phases of the residential construction industry are the management of the construction process and the marketing of the finished product. *Standard The student will develop a thorough understanding of the management skills required to operate successful residential business endeavors.*
64. Commercial Construction Management	Critical phases of the commercial construction industry are the management of the construction of process and the marketing of the finished product. *Standard The student will develop a thorough understanding of the management skills required to operate successful commercial business endeavors.*
65. Stage Technology	With the ever-stronger job market in theater, television, and radio, stage technology is a very important and growing source of employment. *Standard The student will learn all aspects of stage technology and become proficient in the skills and terminology common to the theatrical and media trade.*
66. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering. *Standard Guidance services will be provided to assist students in determining their interests, aptitudes, and abilities; selecting the program that meets their career-vocational education goals; and expanding their individual options.*

67. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. *Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
68. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership development shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society. *Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the use of the democratic process.*

Construction technology standards integrate academic core skills, including:

Language Arts

- Increasing reading comprehension
- Increasing listening skills through verbal instruction
- Developing individual writing style
- Reinforcing speaking skills through demonstrations and presentations
- Expanding vocabulary to include technical terms
- Practicing critical listening skills in a variety of settings

Mathematics

- Developing computational skills
- Reinforcing and extending previously learned mathematical concepts and skills through problem solving
- Reinforcing logic and reasoning
- Using estimating concepts
- Understanding the use of measuring scales
- Using engineering formulas to solve construction technology problems
- Computing and estimating materials, supplies, labor allocation, and costs
- Learning business and accounting skills to use in construction management

Science

- Understanding the basic principles of physics necessary to solve construction technology problems, including problems involving force, mass, distance, time, leverage, and temperature
- Studying the different categories of synthetic abrasives
- Understanding the common chemical characteristics of finishes and their durability and suitability for different purposes
- Understanding the importance of the synthesis of new compounds and the chemical combinations of plastics
- Studying materials and the ways in which they are fabricated

History-Social Science

- Understanding the development and use of hand tools and their effect on our technological society throughout history
- Exploring the development of machine tools and their effect on a technological society
- Exploring the historical development of construction technology, its materials, and its processes
- Understanding the importance of the logging industry, the implications of ecology, modern logging techniques, and the production of materials
- Studying the history of furniture-making as rooted in the development of civilization

- Reviewing historical techniques of surveying, leveling, and other methods of site preparation
- Studying living patterns and conditions and their implications for the construction of structures
- Studying modern plumbing standards and sanitation customs in other countries

Visual and Performing Arts

- Learning that individual ideas and values can be communicated through a well-designed and well-developed product
- Making aesthetic judgments in relation to design
- Learning the use of color, blending, matching, and texture infusion
- Developing awareness of the value of scale and proportions and their contributions to the success and marketability of the product

Diversified Occupations

Standards for diversified occupations constitute a unique framework of service-related programs. The common identifying characteristic linking this diverse set of industrial and technolo y education model standards is that of providing services, both in t e private and public sectors. Model standards provided within the diversified occupations cluster are for the three most commonly taught occupations in California: cosmetology, fire technology, and law enforcement/security services.

Cosmetology

Cosmetology standards identify knowledge of and skills in processes and products necessary to qualify for licensing examinations required by the State Board of Cosmetology. A nationwide advisory committee provides input to the board regarding the requirements of the industry. Model standards encompass separate licensing preparation for the manicurist and the cosmetician.

Cosmetology standards focus on the preparation of individuals for a personal service occupation concerned with the care of hair, complexion, hands, and feet. The cosmetologist is skilled in scalp treatments and in shampooing, rinsing, styling, setting, cutting, dyeing, tinting, permanent waving, and bleaching hair. The cosmetologist also provides facials, manicures, and massage of the hands, arms, feet, and legs. Cosmetology standards emphasize hygiene, sanitation, customer relations, and salon management.

Fire Technology

Fire fighting responsibilities range from protection of wildlands to protection of municipal facilities. Fire fighters may be workers who are fully paid partly paid, or they may be volunteers. Fire technology standards cover personal and employability skills as well as fire fighting and fire control skills. Model standards include fire control techniques; fire department organization; the use of water and other materials in fire fighting; the use of various kinds of equipment such as extinguishers, pumps, hoses, ropes, ladders, gas masks, hydrants, standpipes, and sprinkler systems; methods of entry; arson inspection; and investigation techniques.

A fire technology program encompasses skills necessary for entry-level employment and advanced training. Fire technology standards are articulat[illegible] vith the community college—the primary delivery system for advanced courses in fire science. Fire technology programs serve as a secondary system to provide retraining and upgrading of skills and to offer advanced skill courses. Fire technology standards enhance skills in the academic core.

Law Enforcement/Security Services

Law enforcement/security services model standards are designed to introduce the student to entry-level areas of the administration of justice program. Model standards are designed to develop in the student the skills, knowledge, and abilities necessary to provide the employer with a level of performance sufficient to meet organizational goals and objectives consistently. Students will develop the ability to synthesize cause and effect in scenarios, to anticipate probable outcomes, and to change elements of situations to the extent necessary to effect a more desirable result.

Law enforcement/security services model standards emphasize the necessary attitudes, abilities, habits, and skills to enable students to secure and retain gainful employment in the occupational area. Model standards strengthen academic core skills in the areas of language arts, fine arts, history-social science, mathematics, and science.

As an occupationally specific program, law enforcement/ security services is articulated with the community college, which is designated as the primary delivery system for advanced courses in the administration of justice.

Contents

5. Fire Behavior and Chemistry
6. Hazardous Materials
7. Fire Extinguishers and Extinguishing Agents
8. Hydraulics and Water Appliances
9. Breathing Apparatus
10. Ladders
11. Ropes and Knots
12. Hand Tools: Use/Safety/Maintenance
13. Power Tools: Use/Safety/Maintenance
14. Salvage and Overhaul
15. Ventilation
16. Command Operations
17. First Aid
18. Cardiopulmonary Resuscitation
19. Emergency Medical Technician IA and IFS
20. Fire Prevention
21. Fixed Extinguishing and Alarm Systems
22. Career Guidance
23. Gender Equity
24. Leadership

Law Enforcement/Security Services

1. Professional Orientation
2. Administration of Justice
3. Arrest, Search, and Seizure (PC-382)
4. Criminal Law
5. Public Relations
6. First Aid/CPR and Disaster Preparedness
7. Preliminary Investigation
8. Jail/Prison Operations
9. Licensing and Regulating Agencies
10. Narcotics and Dangerous Drugs
11. Patrol Procedures/Powers of Observation
12. Physical Fitness/Stress Control
13. Preemployment Check and Security Clearances
14. Report Writing
15. Physical Security
16. Evidence, Photography, and Investigation
17. Defensive Tactics/Nonlethal Weapons
18. Attitudes, Behavior: Job Search
19. Career Guidance
20. Gender Equity
21. Leadership
22. Safety

1. Preparation for a Career in Cosmetology	The multifaceted field of cosmetology offers a wide variety of career choices in which students may specialize. It is necessary for students to gain exposure to all aspects of the industry in order to select those areas best suited to their particular interests and capabilities. *Standard The student will understand the ethics of the profession, the varied opportunities within the occupation, and career paths for each area. The student will acquire the information necessary to choose a career path in the field. The student will determine the career areas for which he or she is best suited based on the requirements for achieving entry-level employment. The student will understand the importance of basic written and oral communication skills, computation skills, preemployability skills, and work maturity traits.*
2. Personal Image Improvement	In order to be successful as a cosmetologist, a full range of personal skills, employability skills, and occupation-specific skills are needed. *Standard The student will understand the importance of acquiring qualities and characteristics needed to secure entry-level employment, including an enhancing appearance; good communication skills, positive work attitudes and behaviors; and the ability to conduct a job search and apply for a job.*
3. Sterilization and Sanitation	Because cosmetologists provide services through close physical contact with the public, each has a professional responsibility to protect the health of clients as well as himself or herself. Students will understand the rules, regulations, and practices pertaining to sterilization and sanitation. *Standard The student will understand the cause, prevention, and control of infectious diseases in the salon and practice the procedures for making objects germfree through destruction of bacterial and other infectious agents.*
4. Bacteriology	It is necessary for the cosmetologist to know the relationship between bacteria and disease and to be able to relate that knowledge to the services provided to the public. *Standard The student will understand the cause, prevention, and control of infectious diseases and animal parasites in the salon*
5. Manicuring and Pedicuring: Artificial Nails and Nail Art	The successful cosmetologist must possess a combination of knowledge and skills in order to effectively treat, groom, and adorn hands, feet, and nails under hygienic conditions and in an artistic manner. *Standard The student will develop the ability to recognize the destructive effects of diseases and certain daily activities on the condition of the nails of the hands and feet and know how to treat*

5. Manicuring and Pedicuring: Artificial Nails and Nail Art (Continued)	*them. The student will become proficient in the art of manicuring, pedicuring, applying artificial nails, designing nail arts, and applying polish The student will understand the nature of all materials used for these services.*
6. Shampoos and Rinses	Shampooing the hair, one of the most important services of the cosmetologist, renders the hair and scalp clean and is preliminary to numerous other services. Standard *The student will understand the importance of accuracy and efficiency in selecting the correct type of shampoo and rinse for the customer, based on the condition of the customer's hair and scalp. The student will demonstrate the ability to follow appropriate procedures and techniques.*
7. Trichology: Treatment of Hair and Scalp	Knowledge of the physiology, regeneration, and condition of the hair and scalp is necessary for a cosmetologist to successfully analyze and perform treatments to enhance the hair and scalp. Standard *The student will understand the structure, characteristics, and regeneration processes of the hair; recognize scalp disorders and diseases; and be able to analyze hair and scalp conditions. The student will communicate with the client and effectively select and use products and procedures.*
8. Fundamental and Precision Hair Shaping	To be successful, the cosmetologist must be able to provide both basic and precision haircuts to a wide variety of clients. Cutting skills are prerequisite to providing other services, including hair styling and permanent waving. Standard *The student will understand and demonstrate basic as well as precision haircutting techniques and procedures, employing degrees of angles, elevation, and geometrical patterns. The student will demonstrate the care and use of instruments and hair management.*
9. Principles and Design of Wet Hair Styling	The ability to apply design principles and related skills pertaining to styling wet hair is fundamental to success in the cosmetic profession. To serve a varied clientele effectively, the cosmetologist must have a wide repertoire of knowledge and skills. Standard *The student will understand the principles of wet hair styling and effectively execute hair styles by applying problem-solving and appropriate techniques unique to styling wet hair.*
10. Thermal Hairstyling	Thermal processes of blow-drying, temporarily straightening, or curling very curly hair are in constant demand in the cosmetic indus-

10. Thermal Hairstyling *(Continued)*	try. It is necessary to be proficient in this art form of hairstyling in order to be successful in the field. *Standard The student will analyze a client's scalp and hair as to type and condition. The student will effectively execute hair styles by applying problem-solving processes and by employing techniques and equipment suitable for very curly hair.*
11. Chemical Waving	Chemical waving is one of the most rewarding, yet challenging, salon services offered. In order to provide this service, the cosmetologist draws on a varied background of knowledge of the nature of hair and principles of cosmetic chemistry and must develop a comprehensive set of technical skills. *Standard The student will cultivate the technical knowledge and develop the necessary skills to use chemical waving products, implements, and techniques to permanently curl hair.*
12. Chemical Straightening	Chemical hair straightening is the process of permanently rearranging the structure of overcurly hair into a straight form. *Standard The student will develop the skills and knowledge necessary for hair analysis, the use of available straightening products, and related practices. The student will know the chemicals, implements, and techniques needed to straighten overcurly hair permanently.*
13. Hair Coloring	It is of paramount importance that the cosmetologist thoroughly understand the principles and products involved in hair coloring in order to meet the standards required in the industry. *Standard The student will understand the relationship of the basic laws of color to hair coloring principles and practices and be able to process information and use appropriate techniques when changing hair color.*
14. Hair Lightening	Hair lightening is an important component of the hair colorist's activities. Because hair lightening is sometimes used in combination with other chemical hair treatments, such as coloring, the cosmetologist must be cognizant of the potentially damaging effects of hair lightening on skin and hair and work accordingly. *Standard The student will know the fundamental products and processes of hair lightening, chemical effects on the hair and skin, and appropriate procedures to provide the service and to treat side effects.*

15. Anatomy, Physiology, and Chemistry	A working knowledge of anatomy, physiology, and chemistry, and the applications involved when providing services to the public, is essential to the successful cosmetologist. *Standard The student will recognize, categorize, and compile information about the general anatomical structures and physiological functions of vital organs and systems and be able to identify malfunctions in relation to cosmetic services. The student will differentiate between organic and inorganic chemistry; understand the nature, composition, and properties of elements, compounds, and mixtures of matter; and differentiate between acids and alkalies. The student will understand and recognize the chemical composition of such things as water, shampoo, rinses, permanent waving solutions, hair relaxers, hair color/lighteners, and cosmetics.*
16. Facials	The cosmetologist must be equipped to meet the demands of the public by possessing the knowledge and skills necessary to maintain healthy and youthful looking skin. *Standard The student will understand skin structure, functions, and disorders. The student will demonstrate the skill to execute the recommended preventative or corrective facial treatments.*
17. Make-up	Make-up has historically been used to enhance natural beauty. The selection of color and proper application of make-up is a popular, artistic salon service. It is essential for the cosmetologist to present a professional appearance by wearing artfully and tastefully applied make-up when working with the public. *Standard The student will demonstrate the knowledge and skill to determine face shapes and to apply make-up that will enhance the natural beauty of the client. The student will select appropriate make-up products and apply them in a professional manner.*
18. Hair Removal	The demand for temporary removal of superfluous hair, as a salon service, has increased steadily over the past few years. The focus is on quality service with emphasis on safety and protection for the client. *Standard The student will categorize and organize hair-removal methods, terminology, equipment, and chemicals, including safety precautions and sanitation measures. The student will draw conclusions or make decisions regarding appropriate techniques, equipment, and chemicals required to remove hair, based on individual client needs.*
19. Electricity: Heat and Light	Electrically operated devices play an essential role in the care of clients' skin, hair, and nails. Electricity is an important commodity in the beauty salon since it is the primary power source for various types of equipment used for a variety of treatments involving heat and light.

19. Electricity, Heat and Light (cont.)

Standard ***The student will understand electrical applications, measurements, and terms. The student will analyze the need, select and give treatments, observe precautions, and evaluate results when working with different currents and with heat and lights.***

20. Wigs and Hairpieces

Wig specialists provide a full range of services centered on the selection, use, and maintenance of wigs and hairpieces. The demand for service varies among clients since their wearing needs differ. Typically, the range is from occasional wear, necessitating only one hair goods item with occasional maintenance, to full-time wear, which necessitates having two or more pieces and a rotating, ongoing maintenance program.

Standard ***The student will demonstrate competency in measuring, fitting, and servicing wigs, wiglets, switches, and falls. The student will demonstrate techniques and procedures for cleaning, cutting, thinning, coloring, setting, combing, positioning, and securing a hairpiece on an individual.***

21. Salon Management

Competence in salon management must be based on sound principles of planning and operation in order to ensure success. Consideration must be given to salon location, operating costs, recordkeeping, business establishment laws, and the interpersonal skills of telephone usage and sales practices.

Standard ***The student will, through using sound business and financial management practices, invest in and receive an equitable return from a beauty salon.***

22. Career Guidance

A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering.

Standard ***Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; selecting the program that meets their career-vocational education goals; and expanding their individual options.***

23. Gender Equity

A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today.

Standard ***All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions. No educational program or job should be shown as reflecting on the masculinity or femininity of an individual.***

24. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society. Standard *Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*
25. Safety	All students will be aware of potential hazards, safety rules and regulations, and effective ways of handling accidents as they occur. Standard *The student will have a thorough knowledge of the skills and attitudes necessary for the safe use of tools, machines, materials, and processes and will demonstrate this understanding at all times.*

1. Fire Technology Orientation	The fire technology industry offers a variety of career options. An orientation providing career information covering all aspects of the field is fundamental to the promotion of optimal industry and professional relationships. Standard *The student will understand the regular and emergency duties of a fire fighter and will understand the requirements for achieving entry-level employment. The student will demonstrate entry-level skills, including a core of basic written and oral communication skills, computation skills, preemployability skills, work maturity traits, and the necessary technical job skills. The student will acquire information on the benefits of employment in the fire technology field, learn about professional associations related to the field, and outline a career plan.*
2. Fire Service Organizations	The historical development of the fire service parallels that of the nation. Knowledge of this developmental process provides a frame of reference for understanding the nature of a public service agency. Standard *The student will understand the history of the fire service from its origin to modern times and will understand the rules and regulations governing various fire service organizations.*
3. Water Systems	Knowledge of water systems is an essential aspect of fire fighting. It requires an understanding of sources and distribution methods to promote better use of water, the ability to calculate water source capabilities for realization of limitations and resource allocations, and an understanding of hydrant operations for rapid use of this resource to extinguish fires. Standard *The student will understand the importance of the various water systems and the problems each presents. The student will identify types of fire hydrants and other water sources and demonstrate their uses and capabilities.*
4. Communications	The transmittal of information occurs in numerous ways in the fire service, including through telephones, radios, hand signals, computers, and oral instructions. Effective communication is critical during emergencies and under adverse conditions. Standard *The student will understand the importance of effective communication methods and will demonstrate clear, concise communication skills, using various methods and techniques.*
5. Fire Behavior and Chemistry	An understanding of fire behavior and chemistry is necessary before control agents can be effectively applied. Understanding the dangers and potential of fire behavior is important for fire fighters when determining how and where to work.

5. Fire Behavior and Chemistry (Continued)	*Standard The student will define the fire chemistry needed to produce and promote fires. The student will also define and identify methods of heat transfer, products of combustion, stages of combustion, and classes of fire.*
6. Hazardous Materials	An identification and understanding of hazardous materials and their effects provides the fire fighter with the knowledge and ability to take precautions to prevent injury or death. *Standard The student will identify circumstances that indicate hazardous materials involved in a spill, leak, or fire and will understand the safe corrective actions to be taken. The student will categorize materials by their properties, including the toxic, flammable, explosive, and radioactive. The student will explain the potential effects of hazardous materials and of extinguishing agents to life and environment.*
7. Fire Extinguishers and Extinguishing Agents	Small fires require the proper and safe use of fire extinguishers to prevent fire escalation or possible injury. An understanding of available agents and their properties and capabilities is necessary for proper selection and application techniques when using fire extinguishers. *Standard The student will identify extinguishers and will know the proper type of extinguisher to be used on various types of fuels and fires. The student will demonstrate the method of applying agents on various types of fires. The student will know the safe operation, limitations, and effectiveness of each type of fire extinguisher. The student will know the proper maintenance and testing necessary for each extinguisher.*
8. Hydraulics and Water Appliances	Water is the most available and, therefore, the most commonly used extinguishing agent. Transporting water from the source to the fire scene requires the use of tankers, pumpers, and hoses. Achieving maximum benefit from the extinguishing agent involves prompt use of fire service apparatus and equipment. *Standard The student will apply proper hydraulic principles in operating pumps that draw from various sources of supply. The student will demonstrate differing types of hose lays and use various hose appliances and form applicators.*
9. Breathing Apparatus	Without proper protection, products of combustion and hazardous materials can easily injure a fire fighter. Use of a breathing apparatus is often necessary in search and rescue operations and is an integral part of fire fighting safety. Protective clothing is important in preventing burns and poisoning.

9. Breathing Apparatus *(Continued)*	*Standard The student will describe the operation, maintenance, and limitations of breathing apparatuses. The student will name and describe the function of each part of the breathing apparatuses and protective clothing. The student will demonstrate proper donning of protective clothing and of each piece of breathing apparatus.*
10. Ladders	Ladders are required whenever fire operations or rescues occur above ground level. Ladders are frequently used in adverse weather and under emergency conditions. Proper use and handling of ladders can prevent costly time delays and injuries. *Standard The student will develop the ability to select the proper ladder for an intended use and identify all parts of a ladder. The student will demonstrate, with or without team assistance, the ability to carry, raise, and lower a ladder. The student will explain proper maintenance, safety hazards, and other uses for ladders. The student will demonstrate the ability to carry out a variety of tasks, working from a ladder. The student will describe aerial ladder use.*
11. Ropes and Knots	Ropes are used in a variety of ways in the fire service. A primary purpose of ropes is to haul equipment or people to and from inaccessible places. Proper use and maintenance of ropes is required to prevent injury or loss of life. *Standard The student will identify types, sizes, and uses of ropes. The student will explain proper maintenance and recordkeeping on all ropes. The student will demonstrate all knots and hitches used in the fire service. The student will use ropes to hoist a variety of equipment.*
12. Hand Tools: Use/Safety/Maintenance	Hand tools are used in suppression, forcible entry, ventilation, salvage, overhaul, rescue, and maintenance. Proper working techniques and maintenance of tools help ensure effective extinguishment, rescue, and safety. *Standard The student will identify types of tools and will demonstrate their proper use and maintenance. The student will identify and demonstrate proper safety gear and techniques used with all hand tools.*
13. Power Tools: Use/Safety/Maintenance	Power tools are used in/for suppression, forcible entry, ventilation, salvage, overhaul, rescue, lighting, and maintenance. Proper working techniques and maintenance of tools help ensure effective extinguishment, rescue, and safety. *Standard The student will identify types of tools and their uses, and demonstrate proper activation, use, and maintenance of power tools. The student will identify and demonstrate the proper safety gear and techniques used with power tools.*

14. Salvage and Overhaul	Proper salvage and overhaul techniques can save thousands of dollars in property loss and prevent the rekindling of fires, ensuring the prevention of additional property loss, injuries, or even death. *Standard The student will understand salvage and overhaul concepts and applications. The student will identify and demonstrate the various tools and techniques used in salvage and overhaul operations*
15. Ventilation	An understanding of fire gases and ventilation procedures speeds the removal of smoke and heat to effect rapid and safe fire fighting and rescue operations. Proper ventilation minimizes damage from smoke. *Standard The student will identify and understand the chemistry of fire gases, and especially conditions that contribute to backdraft and flashover. The student will identify and demonstrate the various methods of smoke and heat removal, using proper safety precautions. The student will identify and demonstrate equipment used in ventilation procedures.*
16. Command Operations	Problems encountered in specialized situations such as wildland, high-rise, structure, marine, bulk flammable liquid or gas, aircraft, or train fires require varying operational approaches. *Standard The student will understand and describe methods of fire control, including attack tactics and strategies for a wide variety of situations. The student will define special hazards associated with each special operation. The student will understand special rescue and safety requirements for a variety of situations. The student will demonstrate the ability to make sound command operation judgments.*
17. First Aid	First-aid knowledge and skill is a state requirement for all fire fighting safety positions. It is a prerequisite to the classifications of Emergency Medical Technician IA and IFS. First-aid applications account for a major portion of emergency responses for many municipal fire agencies. First-aid knowledge and skill contribute to safety, both on and off the job. *Standard The student will identify the most common injuries and illnesses, including, but not limited to, bleeding, shock, respiratory arrest, choking, burns, fractures, stroke, drug reactions, and frostbite. The student will demonstrate proper care for each injury or illness as the situation dictates, showing proficiency in bandaging, splinting, airway management, mouth-to-mouth resuscitation, and victim position management.*
18. Cardiopulmonary Resuscitation	Proficiency in cardiopulmonary resuscitation (CPR) is required for most fire fighting safety positions and is a prerequisite to Emergency Medical Technician IA and IFS. CPR is required whenever a person

18. Cardiopulmonary Resuscitation (Continued)

stops breathing or the heart stops beating. Without prompt CPR, irreversible brain damage can occur within four to six minutes.

Standard *The student will identify the circumstances that indicate when CPR is needed and the conditions from which they arise. The student will understand the biological and anatomical effects of CPR and demonstrate the ability to perform every aspect of this process. The student will understand indications and causes of an obstructed airway and demonstrate proper treatment.*

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19. Emergency Medical Technician IA and IFS

The fire fighter's job is not limited to preventing and fighting fires. Often fire fighters are the first responders to an emergency. EMT training is a prerequisite to employment in order to ensure that the fire fighter is able to respond appropriately in medical aid incidents.

Standard *The student will identify most injuries and illnesses and demonstrate proper care for each injury, illness, or situation, including childbirth. The student will know the basic anatomy of the human body. The student will identify common drugs and their effects on the body. The student will demonstrate proficiency in rescue practices involved in extrication from an automobile and other accidents. The student will demonstrate proper handling of situations involving multiple victims and will demonstrate triage procedures.*

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20. Fire Prevention

Fire prevention involves enforcing laws and regulations, conducting arson investigations, and performing public relations and education programs. Often the fire fighter is involved in assisting a fire prevention officer.

Standard *The student will understand laws and ordinances while developing the ability to recognize common violations and hazards. The student will identify key subjects needing coverage in public education programs. The student will recognize signs of an incendiary fire. The student will describe actions to be taken to preserve evidence and will execute the following tasks: determine cause and origin of fires, make routine inspections, give testimony in court, and maintain records and reports.*

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21. Fixed Extinguishing and Alarm Systems

Fixed extinguishing systems, such as sprinkler, dry chemical, and CO_2 systems with detection and alarm systems, are instrumental in saving lives and property through early response to or detection of fires. A thorough understanding of system capabilities, limitations, and operation assists the fire fighter in determining the proper course of action in fire situations.

Standard *The student will identify and understand all fixed extinguishing systems. The student will demonstrate knowledge of proper operation, capabilities, and limitations of these systems through practice in activation, operation, and deactivation.*

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22. Career Guidance	**A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering.** *Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.*
23. Gender Equity	**A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today.** *Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
24. Leadership	**All students will have the opportunity to par' .pate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society.** *Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*

1. Professional Orientation

The law enforcement/security services industry offers a variety of career options. An orientation providing career information regarding all aspects of the field is fundamental to the promotion of optimal industry and professional relationships.

Standard *The student will accurately describe various historical developments in laws and law enforcement and will understand the problems that could exist without present-day laws and professional law enforcement and security services.*

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2. Administration of Justice

Competent performance in law enforcement and security services requires an understanding and working knowledge of the total judicial system.

Standard *The student will recognize the relationship between the three divisions within the administration of justice system. The student will define the three divisions and develop an appreciation of their complexities.*

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3. Arrest, Search, and Seizure

According to the California *Penal Code*, Section 832, any designated peace or security officer who carries weapons in the course of employment must demonstrate a knowledge of laws regarding weapons.

Standard *The student will demonstrate knowledge of laws regarding weapons and will prove skill in the safe handling, operation, and use of lethal and nonlethal defensive weapons. The student will demonstrate approved search and seizure procedures.*

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4. Criminal Law

Knowledge of criminal law is required in order for officers to work within their authority and jurisdiction and to avoid violation of citizen rights.

Standard *The student will possess the ability to recognize violations that an officer is likely to encounter and will know the legal obligations related to the enforcement of laws.*

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5. Public Relations

Tolerance on the part of each officer toward the public served is fundamental to the promotion of public confidence and public support for the entire police and security system.

Standard *The student will understand the importance of effective communications when dealing with the public. The student will develop skills to reduce tension and improve interpersonal relationships.*

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6. First Aid/CPR and Disaster Preparedness

All peace officers in California are required to have knowledge of and skills in first aid, cardiopulmonary resuscitation (CPR), and disaster preparedness, as stated in the *Penal Code*.

6. First Aid/CPR and Disaster Preparedness *(Continued)*	*Standard The law enforcement/security services student will demonstrate the ability to render emergency first aid and CPR. The student will demonstrate appropriate responses to a variety of emergencies that arise in the day-to-day activities of the officer.*
7. Preliminary Investigation	Preliminary investigation is one of the most critical elements of the police and security occupations. Each facet of these career fields requires some level of investigative skill. *Standard The student will recognize important sources of evidence at a crime scene, protect them from contamination, and collect them without destroying their value.*
8. Jail/Prison Operations	The relationship of corrections to the criminal justice system is fundamental to the effectiveness of the law enforcement/security officer. *Standard The student will understand the role and function of the jail/prison structure and identify the major strengths and weaknesses in the system.*
9. Licensing and Regulating Agencies	Individuals must be properly licensed in order to work within the private sector of protective services. Knowledge of licenses and regulations is fundamental to the law enforcement/security services industry. *Standard The student will identify the requirements and develop a plan to obtain all necessary licenses and permits.*
10. Narcotics and Dangerous Drugs	The protective services student must understand the hazards of drug abuse. The protective services officer needs the knowledge and skills necessary to identify the abuser, the narcotics trafficker, and the drugs themselves. *Standard The student will recognize common forms of drugs, narcotics, and other controlled substances. The student will understand the consequences of drug use and abuse.*
11. Patrol Procedures/Powers of Observation	Good patrol procedures and observation skills are essential for the law enforcement/security officer not only for job effectiveness but also for survival. *Standard The student will understand the fundamentals of patrol concepts, basic observational methods, and the major limitations of preventive patrol. The student will understand the service functions of an assignment. The student will appreciate the importance of, and develop ability in, checking the physical security of business places and other high-risk locations as assigned.*

12. Physical Fitness/Stress Control	Physical fitness is important to any citizen, but to a law enforcement or security service officer, it is sometimes critical. A fit officer is better able to react and handle the physical and stressful situations that arise in the course of assignments. *Standard The student will identify the symptoms and hidden sources of stress in everyday life. The student will recognize quality fitness programs that will reduce stress and maintain fitness.*
13. Preemployment Check and Security Clearances	The career in protective services must start with a complete background check to make sure the candidate is of good moral character and meets the employability criteria of the employing agency. Background investigation fundamentals are important to all law enforcement and security service industries. *Standard The student will understand the process and have the ability to conduct preemployment checks and security clearances.*
14. Report Writing	The ability to communicate in written form, providing a clear and accurate picture of events, is critical to effective law enforcement/security service functions. *Standard The student will demonstrate skills in conveying written information in an accurate and understandable form.*
15. Physical Security	Accurate knowledge of the application and function of various security systems and hardware and the ability to conduct physical security surveys are essential in the law enforcement/security services industry. *Standard The student will have a working knowledge of basic security systems and hardware used in the security industry. The student will demonstrate the proper method of conducting physical security surveys.*
16. Evidence, Photography, and Investigation	The officer must know the proper methods of collection and preservation of evidence in order to protect its value. Photography is an alternative method of recording events and objects that cannot be collected as ordinary evidence. *Standard The student will collect evidence at a simulated crime scene in accordance with industry standards. The student will demonstrate competence in the basic use of various types of photographic equipment, including video and 35-mm cameras. The student will demonstrate competence in searching for latent fingerprints by dusting.*

17. Defensive Tactics/ Nonlethal Weapons	The protective service officer may find it necessary to use force in making an arrest and may have to rely on defensive methods for personal well-being. Defensive techniques must be effective without the use of unnecessary force. It is important that the officer be proficient in a variety of defensive techniques. Knowledge and training in the use of a variety of nonlethal weapons is essential. *Standard The student will identify a minimum of four methods of self-defense. The student will give examples of reasonable and unreasonable force and will identify and explain the difference between lethal and nonlethal weapons.*
18. Attitudes, Behavior: Job Search	The potential law enforcement/security services officer seeking employment in protective services work needs basic educational employability skills and preemployment skills in order to apply for, obtain, and keep a job. In order to accomplish these goals, the individual must realize the importance of demeanor, attitude, and behavior in the day-to-day work world. *Standard The student will identify the successful traits and methods necessary to demonstrate when applying for, obtaining, and retaining a position.*
19. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering. *Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.*
20. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. *Standard All students should be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
21. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meetir [illegible] nd personal business skills necessary for relating successfully to [illegible] y.

21. Leadership *(Continued)*	*Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*
22. Safety	**All students will be aware of potential hazards, safety rules and regulations, and effective ways of dealing with accidents as they occur.** *Standard The student will have a thorough knowledge of the skills and attitudes necessary for the safe use of tools, machines, materials, and processes and will demonstrate this understanding at all times.*

Diversified occupations standards integrate academic core skills, including:

Language Arts

- Increasing communication skills, including reading, writing, speaking, and listening
- Expanding vocabulary to include specific and technical terms relating to the occupation
- Interpreting and applying written instructions
- Developing reasoning, problem solving, and critical thinking skills, and the abilities to transfer these skills in a variety of settings
- Interpreting and applying safety precautions
- Writing clear, concise illustrated notes, reports, and records
- Interpreting and implementing the requirements of federal, state, and local laws pertaining to the occupation
- Identifying aspects of nonverbal communication, such as gestures, eye contact, and facial expressions, and using them appropriately

Mathematics

- Reinforcing and expanding computational skills
- Using concepts, theories, and formulas in problem solving
- Using calculators, computers, gauges, scales, and a variety of measuring instruments in calculating and problem solving
- Demonstrating the use of standard units of measurement and the relationship to measurement instruments
- Estimating, calculating interest, and analyzing payroll and financial statements
- Applying problem-solving techniques as applied to statistics, logic, and probability

Science

- Assessing personal habits and developing a plan for practicing proper habits of hygiene, diet, exercise, and weight control
- Classifying the characteristics of bacteria and the relationship to communicable diseases
- Relating facts, terminology, laws, and theories to practical applications in the areas of sanitation, germicides, and antiseptics
- Applying theories of anatomy and physiology to practical applications of services and treatments
- Applying the basic principles of chemistry in determining cause and effect and applying the principles to a specific situation or problem
- Applying scientific knowledge in the processes of informing about, preventing, and controlling safety hazards
- Understanding the structure and composition of various forms of matter and their reactions to other substances
- Understanding the principles of electricity and electronics and their application in a variety of situations and problems

- Identifying and measuring various physical characteristics of substances and their reactions to combustion
- Understanding the principles of pharmacology

History–Social Science

- Learning economic concepts of profit and loss
- Understanding the precepts of entrepreneurship, merchandising, and professional ethics
- Understanding and applying people skills for praising, criticizing, and adjusting conflicts that arise in interpersonal relationships
- Learning about the development of laws and practices as society's responses to the historical and continuing need to protect the health and safety of workers and the public
- Recognizing the cultural and ethnic origins of various foods, cooking methods, and serving styles
- Studying the historical development of the justice system; of politics and public policy; and the origins, background, structure, and operation of American institutions
- Understanding the U.S. Constitution, in particular the civil liberties and civil rights components, and understanding federal, state, and local court systems
- Understanding the cultural and economic impact of correctional institutions
- Studying the economic impact of drugs on society

Visual and Performing Arts

- Making aesthetic judgments and experiencing satisfaction and feelings of accomplishment
- Using artistic expression to reflect personal and cultural ideals when developing hairstyles
- Expressing creativity through the use of skillful communication with the client regarding desired results, conceptualizing, and creating the end product
- Engaging in activities directed toward the refinement and mastery of artistic skills, using color and design
- Understanding and developing techniques for enhancing personal appearance, vocal presentations, and overall appearance

Electronics Technology

Electronics technology standards focus on student acquisition of new knowledge, awareness of individual interests and abilities, and application and transfer of skills learned in other disciplines.

The student of electronics technology becomes familiar with historical, current, and potential developments in industry and technology, as well as the effects of such developments on consumers and members of society. As a result of participation in electronics technology, the student will be able to make informed career/occupational (educational) decisions based on the knowledge and skills acquired and related to personal interests and aptitudes.

Contents

1. Understanding Electricity/Electronics
2. Electricity/Electronics Safety
3. Methods of Generating Electricity
4. Wiring Tools and Wire
5. Soldering
6. Magnetism and Electromagnetism
7. Circuits, Symbols, and Component Identification
8. Resistors and Identification Systems
9. Available Sources of Earth Energy
10. Small Appliance Repair
11. Exploration of Occupations
12. Historical Development of Electricity/Electronics
13. Basic Electrical Skills
14. The Flow of Electricity Through Conductors and Insulators
15. The Electrical Team
16. Components, Switches, and Circuits
17. Electric Lamps and Heating Devices
18. DC and AC Electricity
19. Motors and Generators
20. Low-Voltage Circuit Wiring and Signal Devices
21. Circuit Protection Devices
22. House Wiring
23. Electronics Mathematics Fundamentals
24. Communication Systems
25. Direct Current Circuits
26. Direct Current Circuit Evaluation
27. Electrical Energy and Power
28. Project Fabrication Techniques
29. Alternating Current Fundamentals
30. Instrumentation
31. Capacitance
32. Inductance
33. Circuits Containing Resistance, Capacitance, and Inductance
34. Vacuum Tube and Solid-State Electronics
35. Solid-State Devices
36. Printed Circuits

37. Basic Electronic Stages
38. The Power Supply Stage
39. The Amplifier Stage
40. The Oscillator Stage
41. Fundamentals of Radio Broadcast Systems
42. Overview of Electronic Systems
43. Introduction to Integrated Circuits
44. Linear Integrated Circuits
45. Digital Circuits
46. Optoelectronics
47. Microprocessors
48. Career Guidance
49. Gender Equity
50. Leadership

1. Understanding Electricity/Electronics	Electricity is one of the most important forms of energy used in the world today. Radio, television, phone communication, computers, satellites, lighting and heating systems, industrial control systems, and transportation systems would be vastly different or nonexistent without electricity. A large percentage of the work force in the United States today is employed in jobs related to electricity and electronics. *Standard The student will comprehend the importance of electricity and electronics in today's society and will understand the basic science of electricity.*
2. Electricity/Electronics Safety	Safety is an essential part of all electronics activities, and the fundamentals needed to prevent accidents must be included and stressed in all applications of electricity and electronics. *Standard The electronics student will understand the importance of safety on the job, in the classroom, and at home and will demonstrate the ability to perform all tasks in a safe manner, using correct techniques and procedures.*
3. Methods of Generating Electricity	The engineer and technician should be aware that the generation of electricity is a process of converting one form of energy to a different form of energy. *Standard The student will understand the concept of energy conversion and the different methods of generating electricity.*
4. Wiring Tools and Wire	Wire is one of the primary types of conductors used to connect electrical circuits. Proper use of wire and wiring tools is a necessary and important part of electronics work, and all technicians and engineers must be familiar with sizes and types of wire and the specialized tools used. *Standard The student will be familiar with the various types and sizes of wire and the specialized tools required in circuit fabrication and repair.*
5. Soldering	The art of soldering metal has been practiced for many centuries and is one of the most important methods used to ensure electrical continuity between connected points. Because most electronic devices use solder connections, the electronics technician must know correct soldering techniques. *Standard The student will understand the techniques of modern soldering practices and develop skills for making good solder connections.*

6. Magnetism and Electromagnetism	A knowledge of the fundamentals of magnetism and electromagnetism is a prerequisite to understanding electric generators, motors, electromechanical control systems, and radio communication systems. All engineering and technical occupations in the work force today require people with knowledge and skills in these areas. *Standard The student will understand the relationship between atomic theory and magnetism and between magnetism, electromagnetism, and magnetic induction.*
7. Circuits, Symbols, and Component Identification	The application of electricity and electronics in lighting, heating, computers, communication, and industrial control systems involves a variety of components. A special graphic symbol designates each specific component in diagrams called schematics. Knowledge of circuits, symbols, and component identification is a necessary and important part of the electronics industry. *Standard The student will understand circuits, symbols, and component identification and be able to identify and draw various circuit configurations, using proper symbols.*
8. Resistors and Identification Systems	Resistance to current flow is an important parameter associated with all electronic circuits. Manufactured resistors are usually used in electronic circuits either to divide voltage or to limit current flow. Various schemes are used to indicate the resistance value of manufactured resistors. *Standard The student will understand the concept of resistance in electronic circuits, identify schematic symbols for resistive devices, and be able to interpret various resistor value coding systems.*
9. Available Sources of Energy	The availability of adequate future energy sources—such as fossil fuels—is a major concern of all industrialized nations of the world. Conservation and cost-effective methods of converting existing energy into electricity are of paramount importance. *Standard The student will study the generation of electricity and understand that it is an energy conversion process. The student will be able to describe various types of electrical power generation facilities with an awareness of the comparative cost-effectiveness of each type, keeping in mind principles of conservation.*
10. Small Appliance Repair	Service occupations will continue to require a large work force in the United States, including technicians with a basic knowledge of electricity/electronics to service office equipment and household and other appliances. *Standard The student will be able to perform basic inspection, testing, and troubleshooting to locate and repair simple defects of*

10. Small Appliance Repair *(Continued)*	*malfunctioning appliances and to identify and locate sources of replacement parts.*
11. Exploration of Occupations	The choice of an occupation is a very important, but difficult, decision for many young people. The educational system should not only equip students with the knowledge and skills necessary to become productive members of society but also help them understand the qualifications and expectations required of a person in a number of occupations. Many jobs in the work force require people with knowledge and skill in electricity nd electronics. *Standard The student will understand the skills, qualities, and educational requirements needed for employment in a variety of occupations. The student will develop an awareness of occupational choices and will be encouraged to participate in a student youth organization to learn and practice leadership skills.*
12. Historical Development of Electricity/Electronics	The science of electricity/electronics spans several centuries. New discoveries and developments in this discipline are almost always extensions of previous scientific knowledge. *Standard The student will understand that state-of-the-art electronics stems from scientific principles discovered, in some cases, many years ago and will recognize that new discoveries will continue to be built on existing scientific and technical knowledge.*
13. Basic Electrical Skills	In a technological society, skill in the identification, selection, and use of common testing equipment and specialized hand tools is a prime prerequisite. Technicians, engineers, and other professionals will work with tools ranging from simple hand tools to complex electronic testing sets and equipment. *Standard The student will develop skills in selecting and using the appropriate hand tools and electronic test equipment and will understand the importance of proper tool and instrument maintenance. The student will also develop effective troubleshooting techniques and the ability to work with modern components.*
14. The Flow of Electricity Through Conductors and Insulators	For electricity to serve a useful purpose, it is essential that its flow be directed and controlled. Some materials have properties that require very little external energy (voltage) to cause a movement or flow of electrons, while others require considerable amounts to produce electron flow. Technicians, engineers, and other professionals must be able to use, classify, and differentiate among various types of conductors, semiconductors, and insulators. *Standard The student will know the difference between conductors, insulators, and semiconductors and will be able to relate the importance of each of these materials in the study of electricity/electronics.*

15. The Electrical Team	In all scientific disciplines there are many parameters and units of measure. An awareness of fundamental units of measure associated with electricity/electronics is necessary. Amperes, volts, and ohms are three examples of electrical quantities that need to be identified. *Standard The student will be able to define the terms ampere, volt, and ohm and will be able to use appropriate testing equipment to measure basic circuit parameters in amperes, volts, and ohms.*
16. Components, Switches, and Circuits	Radios, televisions, computers, industrial control systems, and other electrical and electronic devices use certain components to control or modify electron flow. Technicians, engineers, and other professionals must understand the functional characteristics of these components and the various circuit configurations. *Standard The student will understand component identification, characteristics, circuit configurations, and the various circuits that may be constructed using these components. The student will apply critical thinking to troubleshoot and solve circuit malfunctions.*
17. Electric Lamps and Heating Devices	Electricity is the most significant source of home and industrial lighting. Heat generated by electricity is used for industrial processes and for home use. *Standard The student will understand the theory, operation, and identification of electrical lighting and heating circuitry.*
18. DC and AC Electricity	There are two general classifications of electricity—direct current (DC) and alternating current (AC)—both of which are widely used in electronic circuitry. Each has its particular application, and it is essential that the technician and engineer know the similarities and differences between DC and AC electricity, as well as their applications. *Standard The student will understand the advantages and disadvantages of various applications of DC and AC electricity and recommend the form of electricity that would be better for a technical application.*
19. Motors and Generators	Conversion of mechanical energy into electrical energy is the method that produces approximately 90 percent of the electricity used in the world today. A large percentage of the electricity produced is used to drive electric motors. These motors are used extensively in commercial, industrial, and residential applications. A large work force is involved in the design, manufacture, operation, and maintenance of electric motors and generators. *Standard The student will be able to identify and understand the operating principles of various types of motors and generators and describe the advantages and disadvantages of each.*

20. Low-Voltage Circuit Wiring and Signal Devices

Low-voltage signal circuits are used in industrial, commercial, and residential systems for signaling and controlling other devices. These signals can be used, for example, to activate security alarms or remote power control circuits.

Standard The student will understand the theory of operation for a typical low-voltage signal system and will know how it interconnects with other systems for proper operation. The student will acquire enough information to be able to recommend the proper low-voltage circuit for use in a particular application.

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21. Circuit Protection Devices

Most electrical and electronic circuits incorporate protective devices, such as fuses, fusible links, or circuit breakers. The theory of operation of all these protective devices is similar. The technician or engineer must always consider circuit safety as a prime prerequisite in circuit design.

Standard The student will understand the need for circuit protection devices and their operation within designed limits, recognize the various types, recommend or select an appropriate one for a given application, and understand the testing procedures used with circuit protection devices.

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22. House Wiring

The most widespread use of electricity and electronics is in house wiring. Houses use wires to carry current from the distribution point to convenience outlets, lighting fixtures, and appliances.

Standard The student will understand correct and safe procedures for installing house wiring, how house circuit breaker values are calculated, how the size of the wire is determined, and how color coding is used. The student will comprehend the correct use of outlets, switches, boxes, junctions, and other house wiring devices.

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23. Electronics Mathematics Fundamentals

Electronics is an application and extension of mathematics. Full comprehension of electronic laws and theorems requires an understanding of mathematics.

Standard The student will understand the principles involved in solving mathematical, algebraic, and trigonometric problems as applied to electronic circuits and will learn and use scientific notation and metric prefixes as applied in mathematical calculations.

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24. Communication Systems

Communications is an essential and increasingly vital part of human life. Electronics has allowed communications to be carried over great distances, both on earth and in space, in forms ranging from the simplest telegraph to the most complex satellite, all having their foundations in the science of electronics.

24. Communication Systems *(Continued)*	*Standard* ***The student will understand the concepts and principles of many types of electronic communication systems, will comprehend the principles of information conversion into electronic signals, and will understand the transmission, reception, and ultimate conversion of these signals back to intelligible information.***
25. Direct Current Circuits	Radios, television sets, computers, and most other types of electronic equipment require direct current (DC) for operation. For this reason, it is essential that technicians and electronics engineers have an understanding of the laws and characteristics governing DC circuits. *Standard* ***The student will understand the basic relationships between voltage, current, and resistance as they relate to direct current circuits and will be able to calculate and measure these relationships.***
26. Direct Current Circuit Evaluation	Electricity and electronics are scientific disciplines that express relationships related to circuits. Comprehensive examinations of Ohm's and Kirchhoff's laws are prerequisites to understanding fundamental direct current circuits. *Standard* ***The student will be able to apply Ohm's and Kirchhoff's laws in detailed circuit analysis.***
27. Electrical Energy and Power	The widespread domestic, commercial, and industrial applications of electrical energy in the United States are extensive and taken for granted. Most electricity is produced by some energy conversion process, and a major portion is used to power electric motors, heating systems, and lighting systems. *Standard* ***The student will become familiar with the terminology of electrical energy and power and will understand the power law as it relates to circuit evaluation and Ohm's law in circuit analysis. The student will understand the relationship between power, heat, and energy and how they relate to energy cost and conservation.***
28. Project Fabrication Techniques	The manufacturing of industrial, commercial, consumer, and military products requires a large work force skilled in the use of tools and equipment and familiar with complex fabrication processes. *Standard* ***The student will achieve competency in the use of tools, equipment, and processes involved in the fabrication of circuit boards, wiring harnesses, and associated electronic equipment. The student will develop the critical thinking skills needed to troubleshoot malfunctioning circuits.***
29. Alternating Current Fundamentals	The most widely used electrical current supplied to our homes, schools, businesses, and industries is alternating current (AC). All types of electronic communications employ some application of alter-

29. Alternating Current Fundamentals *(Continued)*

nating current. Numerous occupations, even outside electronics, require employees who have a working knowledge of alternating current.

Standard The student will understand how alternating current is generated, its characteristics, the common terminology associated with the sine wave, the basic characteristics of alternating current circuits, and the nature of the frequency spectrum, including the frequency ranges used in radio communications.

30. Instrumentation

The electronics industry uses measuring and testing equipment extensively. Meters and testing devices of all types are the working tools needed to measure the electrical manifestations of voltage, current, and resistance in electronic circuitry. It is essential for technicians and engineers to have a good working knowledge of electronic measuring and testing equipment.

Standard The student will understand the importance of and the function of electronic test equipment and know how to use the equipment to measure the parameters of a circuit. The student will understand the concepts of signal injection and signal tracing as a troubleshooting technique.

31. Capacitance

Capacitors are major components in most electronic circuits. The devices have the ability to store an electrical charge, which makes them valuable in filter networks, tuners, motor starters, timing circuits, and many other applications. Technicians and engineers must have a fundamental knowledge of capacitance and capacitive reactance.

Standard The student will understand physical and electrical properties of capacitors and be able to describe the characteristics of capacitance in both AC and DC circuits. The student will be able to understand and use the terminology necessary to work with capacitors and capacitance, to explain the significance of the variables in the capacitive-reactance formula, and to determine time constants of various resistive-capacitive circuits. The student will understand the special danger associated with capacitors, will apply the appropriate safety precautions, and will be able to use appropriate instrumentation in the measurement of circuit values.

32. Inductance

Inductors are one of the major components in most electronic circuits. They have the property of electromagnetically storing charges, making them valuable in filter networks, tuners, timing circuits, and other current-control applications. Technicians and engineers must have a fundamental knowledge of inductance and inductive reactance.

Standard The student will understand the physical properties of an inductor, describe the characteristics of inductance, use the termi-

32. Inductance *(Continued)*

nology necessary to work with inductors and inductance, explain the significance of the variables in the inductive-reactance formula, and determine time constants of various resistive-inductive circuits. The student will acquire an awareness of the extensive uses of inductors and inductance in industrial applications.

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33. Circuits Containing Resistance, Capacitance, and Inductance

Circuits containing resistance, capacitance, and inductance are called "tuned circuits." Radio, television, and telephone communication systems have made extensive use of tuned circuits. Technicians and engineers need to understand the characteristics of tuned circuits.

Standard The student will understand the nature, characteristics, and elements of tuned circuits; be aware of their importance; and understand the concepts of electrical resonance.

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34. Vacuum Tube and Solid-State Electronics

Vacuum tubes, semiconductors, and solid-state devices have revolutionized the electronics industry, which in turn has had a tremendous impact on today's society. Semiconductors are the heart of computers, communication systems, industry automation systems, electronic military hardware, medical electronics, and many consumer goods. Solid-state technology has replaced vacuum tubes except in a few specialized applications. The demand for technicians and engineers skilled in solid-state and vacuum tube theory will continue to be strong for the remainder of this century.

Standard The student will understand the historical and present-day importance of vacuum tube and solid-state technology. The student will understand the role of "active devices" in amplifiers, rectifiers, oscillators, and logic circuits and will be familiar with methods and materials used for solid-state devices.

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35. Solid-State Devices

Semiconductors and solid-state devices have had a tremendous impact on the electronics industry and are at the heart of computers, communication systems, industry automation systems, automotive electronic control units, electronic military hardware, and many consumer products. The electronics industry, including the design, manufacture, and service functions, will continue to require a large work force of technicians and engineers.

Standard The student will understand basic semiconductor physics, characteristics and applications of diodes, positive-negative (PN) junction unijunction, and field-effect transistors, basic transistor circuit configurations, and the use of equipment for testing semiconductors and associated circuitry.

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36. Printed Circuits

Printed circuit boards—boards with the wiring printed or etched on them—have greatly enhanced the automated manufacturing and quality of electronic systems and subsystems. This technology will

36. Printed Circuits *(Continued)*	continue to be used and refined by the electronics industry. Technicians and engineers with printed circuit fabrication and process skills will continue to be in demand in industry. *Standard The student will understand circuit board design and layout, fabrication processes, manual and automatic loading of components on the board, soldering techniques, and servicing procedures.*
37. Basic Electronic Stages	Most electronic systems, for example radios, televisions, and computers, consist of many subsystems or stages. Technicians and engineers are required to have the special skills needed to make an operational analysis at the component, stage, subsystem, and system levels. *Standard The student will understand the function of individual electronic stages and how they relate to each other. These interactions must be understood and analyzed with respect to operating characteristics and become a part of the critical-thinking process in troubleshooting malfunctioning systems. Synthesis, deduction, inferential thinking, and evaluation skills will be strengthened as the student follows circuit operation through stages or block diagrams.*
38. The Power Supply Stage	Computers, communication systems, and most electronic circuits require a source of direct current (DC) supply. The voltage from public utilities is alternating current (AC) and must be converted to supply direct current. Circuits that will efficiently convert alternating current to direct current are of prime importance. A comprehensive background in power supplies is needed by technicians and engineers involved in the design and maintenance of electronic equipment. *Standard The student will understand rectification, filter systems, regulation systems, and voltage divider networks. The student will have the ability to measure output voltages, percentage of ripple, and percentage of regulation and will be able to identify various power supplies and their operations.*
39. The Amplifier Stage	Electronic amplification is used extensively in industrial, military, and consumer electronics systems. It is imperative that electronics engineers and technicians understand the principles of amplification and the various classes of amplifier stages. *Standard The student will learn and understand the various classes of amplifiers, amplifier circuit configurations, current gain, voltage gain, input and output, impedance, small signal and power amplifiers, and frequency response, all of which are important amplifier stage attributes.*

113

40. The Oscillator Stage

The properties of oscillators and resonant circuits are basic to communication and other types of electronic equipment. Technicians and engineers with a knowledge of oscillators and resonant circuits will continue to require this knowledge in the electronics industry.

Standard The student will understand the principle of resonance and various types of oscillator circuits and will be able to analyze data drawn from operating circuits.

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41. Fundamentals of Radio Broadcast Systems

In the last decade, there has been a phenomenal increase in entertainment and business-type data that are transmitted via radio. Satellite communication networks have made worldwide communication a reality. The communications industry will continue to need a large work force of technicians and engineers to design, manufacture, and maintain equipment.

Standard The student will understand basic radio frequency circuitry associated with processes of modulation, heterodyning, intermediate frequency amplification, detection, and automatic gain, along with the frequency controls used in most electronic communications systems. The student will develop an appreciation for the historical evaluation of broadcast receivers and transmitters.

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42. Overview of Electronic Systems

Working in the electronics field requires an understanding of how individual circuits, components, and assemblies integrate into complete systems and devices. Because technicians and engineers function largely as specialists working on specialized equipment, it is imperative that they comprehend the general characteristics of many systems in order to make decisions concerning their own specialties.

Standard The student will develop a general understanding of radio, television, telephone, microwave, computer, and detection systems and be able to identify specialized equipment for study.

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43. Introduction to Integrated Circuits

Since the invention of the transistor in 1947, electronics manufacturers have attempted to miniaturize components and circuits and to reduce costs while maintaining reliable devices. Large-scale integration (LSI) of circuits incorporating the equivalent of thousands of discrete components makes it possible to produce powerful calculators, radios, and microprocessors on a single device, called a "chip." This requires many workers, including technicians and engineers, with a working knowledge of the applications of integrated circuits.

Standard The student will study and comprehend integrated circuit fabrication techniques, input and output signals, biasing voltages, integrated circuit terminology, and testing procedures.

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44. Linear Integrated Circuits

Linear integrated circuits have many uses in consumer and military products. These circuits can perform almost all functions associated with linear electronics that deal with amplified waveform reproduction. Linear integrated circuits are used in many of the newer consumer products, such as AM/FM radios, televisions, and audio and video recorders.

Standard The student will understand linear integrated circuit terminology, applications, symbols, and advantages, as compared to those of discrete components.

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45. Digital Circuits

Recent trends in the electronics industry have been toward greater applications of digital circuits. These circuits are being used in increased applications in what was once the exclusive domain of analog circuits. Digital circuits are the heart of most computer systems. Many occupations require an understanding of digital circuitry.

Standard The student will understand digital integrated circuit terminology, number systems, logic functions, and applications to electronic systems. The student will compare analog to digital integrated circuits and be able to design digital circuits, using logic functions.

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46. Optoelectronics

Optoelectronic devices are rapidly finding a market in the electronics industry. This technology—light, light sources, light amplification, and optical displays—is being used in military, industrial control, and consumer products. Applications of these devices will increase; the technician and engineer should be familiar with them.

Standard The student will understand basic optoelectronic circuitry, the nature of light, light sources, light amplification, and optical displays.

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47. Microprocessors

Microprocessors are now into advanced generations of development and have a powerful impact on military and consumer products. These devices are the heart of computers and are used extensively in manufacturing, process controls, home appliances, automotive controls, and in many applications to commercial and military electronics. This software and hardware approach to technology will continue to expand and will require many skilled workers to design, manufacture, and service systems using microprocessors.

Standard The student will understand microprocessor fundamentals, terminology, architecture, bit capacity, and the roles of software and hardware.

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48. Career Guidance

A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed

48. Career Guidance *(Continued)*	to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering. *Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational preparation goals; and in expanding their individual options.*
49. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. *Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
50. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership development shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society. *Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*

Electronics technology standards integrate academic core skills, including:

Language Arts

- Reading and comprehending written instruction and technical literature on electronics
- Listening to and following verbal instructions
- Expanding terminology and vocabulary by listening, writing, evaluating, and speaking about electronics
- Keeping written logs and reports of experiments and definitions

Mathematics

- Learning positive and negative numbers
- Working with whole numbers, addition, subtraction, multiplication, and division
- Learning the concepts of powers of 10, scientific notation, and engineering notation
- Calculating correct wire size for current-carrying capabilities
- Working with percentages and ratios as applied to electronics
- Algebraically solving formulas as applied to electronic circuits, signal transmission, and modulation
- Computing salaries, benefits, and employment costs for electronics occupations
- Using trigonometry functions to solve alternating current problems and in work involving impedance, resonance, oscillators, and filters
- Applying mathematical concepts and principles to alternating current for wave frequency, time, period, alternation, peak, peak-to-peak voltage, current, and effective and average values of the sine wave
- Applying basic mathematics to solve problems involving power and horsepower
- Using Boolean algebra to work with logic functions and comparing and studying binary, octal, and hexadecimal number systems
- Using Karnaugh maps to represent and solve for analysis of logic functions

Science

- Studying electrical concepts of lodestones, magnets, static electricity, negative and positive charges, direct current, electromagnetism, and alternating current
- Studying atomic and electron theory as it applies to electronics
- Studying the laws and theories of physical science as they relate to induction, frequency, polarity, cycles, series and parallel circuits, power, energy, and phase relationship
- Studying the three states of matter and how they apply to electronics
- Studying the sources and types of energy: nuclear, chemical, piezoelectric, wind, geothermal, thermal, hydro, fuel cells, solar, and fossil fuels

- Studying the scientific relationship between electrical and mechanical energy
- Recognizing the scientific principles relating to heat production when current flows in a circuit
- Studying the physics of audio and radio frequency generation, modulation, demodulation, and waveform generation with harmonic frequencies

History–Social Science

- Emphasizing the study of electricity from as early as 600 BC through the twentieth century
- Studying the economic factors affecting the cost of manufacturing, selling and producing electronic equipment
- Studying the historical development of electricity generation, including the economics of the different methods of generating electricity
- Studying the development of wire and wiring tools and the economics affecting the cost of wire, tools, and hand-wiring methods
- Studying the early pioneers, such as George Simon Ohm, Count Alessandro Volta, Andre Marie Ampere, George Westinghouse, Sir Isaac Newton, Michael Faraday, Gustav Robert Kirchoff, Thomas A. Edison, Nikola Tesla, Lee de Forest, Edwin Howard Armstrong, William Bradford Shockley, James Watt, Heinrich Rudolf Hertz, and Marchese Guglielmo Marconi
- Studying the historical development of the earth's electrical energy sources
- Exploring the historical development of unions and professional and trade occupations, including the economics and salary ranges of the various occupations in electronics
- Identifying historical changes in industry, business, the home, and modern life with the advent of alternating current and direct current electrical transmission
- Identifying and tracing the historical changes and advances in the design and manufacture of motors and generators
- Tracing the historical changes in house wiring methods and studying the development and implementation of the Rural Electrification Act (REA)
- Identifying the historical development of electronic communication systems from the telegraph to present state-of-the-art communication systems
- Studying the development of communications, computers, and consumer electronics systems and their impact on the economy

Manufacturing Technology

Manufacturing technology standards address grade levels nine and ten. Areas addressed reflect a broad range of experiences of manufacturing and production technology. Specifically, standards address the following: management technology, production technology, personnel management, careers in manufacturing, tool technology, measurement systems, manufacturing materials, metallurgy, material removal and coating processes, industrial forming processes, and industrial joining processes.

Machine tool technology standards address grade levels eleven and twelve, ROP/Cs, and community colleges. Areas addressed are those that typically lead toward job placement and possible certification. Specifically, standards address the following: measurement systems, print reading, properties of metal, cutting theory and cutting tool materials, cutoff machines, drills and drilling, lathe processes and procedures, metal finishing, material testing, nonconventional machining, milling machine processes and procedures, layout, cutting fluids, abrasives, heat treatment, applied mathematics, numerical control, and quality control.

Plastics technology standards address grade levels eleven and twelve, ROP/Cs, and possible community college programs. The areas addressed are those that typically reflect industrial standards and lead toward employment in the expanding fields of plastics and composites. The units specifically address the following: safety, basic plastics processes, mold preparation, plastics material identification, repair of plastics materials, bonding methods, production systems, tooling for plastics, advanced composites, print reading, and job placement skills.

Welding technology standards address grade levels eleven and twelve, ROP/Cs, and community colleges. Areas addressed are those that typically lead toward job placement and possible certification. Specifically, standards address the following: safety, welding materials (both base and filler metal), joint preparation, welding positions, print reading, testing and inspection, oxyacetylene welding (OAW), arc welding (SMAW), MIG welding (GMAW), and TIG welding (GTAW).

Contents

Manufacturing Technology

10. Soldering/Brazing
11. Fastening—Bonding/Chemical
12. Mechanical Fastening
13. Threads and Thread Cutting
14. Metal Finishing
15. Drilling
16. Filing
17. Sawing
18. Turning
19. Grinding
20. Milling
21. Flame/Arc Cutting
22. Industrial Forming Processes—Casting
23. Industrial Forming Processes—Forging
24. Industrial Forming Processes—Sheet Metal Fabrication
25. Industrial Forming Processes—Cold Working
26. Industrial Forming Processes—Shearing
27. Computer-Aided Manufacturing
28. Computer-Integrated Manufacturing
29. High Technology Industrial Processes
30. Computer-Aided Design and Drafting
31. Flexible Manufacturing Systems
32. Career Guidance
33. Gender Equity
34. Leadership

Machine Tools

1. Cutting Action Theory
2. Cutting Tool Materials
3. Linear Measurement
4. Materials Testing
5. Metal Finishing—Mechanical
6. Properties of Metals
7. Semiprecision Measuring Tools
8. Precision Measuring Tools
9. Print Reading
10. Quality Control and Inspection
11. Abrasive Machining and Grinding
12. Abrasive Machining and Grinding—Abrasives
13. Abrasive Machining and Grinding—Equipment
14. Computer Numerical Control/Numerical Control—Robotics
15. Computer Numerical Control/Numerical Control—Controls
16. Computer Numerical Control/Numerical Control—Basic Programming
17. Computer Numerical Control/Numerical Control—Machine Tools
18. Cutting Fluids
19. Cutting Fluids—Categories
20. Cutting Fluids—Selection
21. Drill Press
22. Twist Drill

23. Industrial Materials
24. Industrial Materials—Ferrous
25. Industrial Materials—Nonferrous
26. Industrial Materials—Nonmetallic
27. Industrial Materials—Heat Treating
28. Industrial Materials—Hardness Testing
29. Lathe
30. Lathe—Line of Power
31. Lathe—Work-Holding Devices and Accessories
32. Lathe—Cutting Tools
33. Lathe—Work Processes/Operations
34. Lathe—Speeds and Feeds
35. Layout
36. Layout—Procedures
37. Layout—Equipment
38. Layout—Semiprecision
39. Layout—Precision
40. Milling Machine
41. Milling Machine—Line of Power
42. Milling Machine—Work Holding
43. Milling Machine—Work Processes
44. Milling Machine—Speeds/Feeds
45. Nonconventional Machining
46. Stock Cutoff Machines
47. Technical Mathematics
48. Technical Mathematics—Fractions/Decimals
49. Technical Mathematics—Formulas/Algebra
50. Technical Mathematics—Geometry
51. Career Guidance
52. Gender Equity
53. Leadership

Plastics

1. Safety
2. Plastic Process Introduction
3. Molding Processes
4. Reinforcement Processes
5. Thermoforming Processes
6. Nonmetallic Casting Processes
7. Foaming Processes
8. Mold Preparation
9. Plastic Material Identification
10. Repair of Plastic Materials
11. Nonmetallic Bonding Methods
12. Mass Production
13. Tooling for Plastics
14. Advanced Composites
15. Print Reading
16. Career Guidance
17. Gender Equity
18. Leadership

Welding

1. Safety
2. Joint Preparation
3. Welding Materials
4. Welding Positions
5. Welding—Electrodes and Filler Metal
6. Shielded Metal Arc Welding (SMAW)—Equipment
7. Shielded Metal Arc Welding (SMAW)—Techniques
8. Oxygen Acetylene Welding (OAW)—Cutting
9. Oxygen Acetylene Welding (OAW)—Equipment
10. Oxygen Acetylene Welding (OAW)—Techniques
11. Gas Tungsten Arc Welding (GTAW)—Equipment
12. Gas Tungsten Arc Welding (GTAW)—Manipulation
13. Gas Tungsten Arc Welding (GTAW)—Electrode Selection, Shielding Gas Selection
14. Gas Metal Arc Welding (GMAW)—Wire Selection, Shielding Gas Selection
15. Gas Metal Arc Welding (GMAW)—Manipulation
16. Gas Metal Arc Welding (GMAW)—Equipment
17. Testing and Inspection
18. Print Reading
19. Other Welding Processes
20. Distortion in Fabrication and Its Control
21. Career Guidance
22. Gender Equity
23. Leadership

1. Manufacturing Enterprise

The knowledge of how manufacturing enterprises are organized is essential in order to understand how goods and services are produced and provided in the world community.

Standard The student will understand how manufacturing enterprises are organized with relation to types of organization and ownership, marketing of a product, safety management, and product liability.

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2. Production Technology

The study of production systems is basic to the understanding of how products are developed and manufactured.

Standard The student will understand how research and development, product design, and documentation culminate in a prototype from which tooling is developed and products produced.

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3. Personnel Management

Modern manufacturing practices require a thorough understanding of careers and personnel management.

Standard The student will understand modern personnel management practices, including the topics of labor relations, employment procedures, dismissal practices, human resources development, and careers.

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4. Safety

Safety practice is an essential part of all manufacturing activities. Fundamental safety procedures and understanding are essential to the instruction practices in applied education.

Standard The student will understand the importance of safety in the classroom, on the job, and in personal activities. The student will demonstrate the ability to perform all tasks in a safe manner, using correct techniques and procedures.

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5. Measurement

Accuracy in measurement and interpretation is essential in the manufacturing field. A practical understanding of dimensions, units of measure, measurement systems, and terminology are necessary for proficiency in manufacturing and related technologies. Interchangeable manufacturing parts and close tolerances have made measuring a vital skill in most technical fields.

Standard The student will develop and demonstrate a working knowledge in the use of a variety of measuring instruments. The student will develop an understanding of fractions, decimals, and mathematical formulas as used in manufacturing.

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6. Hand and Power Tools

A working knowledge of the use and care of a wide variety of hand and portable power tools is essential because most manufacturing processes require the use of these tools for one purpose or another.

6. Hand and Power Tools *(Continued)*	*Standard* ***The stud.* **nt will demonstrate a working knowledge and skill with the use of various hand and power tools. The student will demonstrate safe practice in the use of hand tools to prevent personal injury or machine, tool, or work-piece damage.***
7. Materials—Metallic/Nonmetallic	The ability to identify, analyze, and process various materials in a variety of manufacturing processes is a basic requirement of today's manufacturing systems. *Standard* ***The student will develop an understanding of today's manufacturing materials, their sources, and their working properties. The student will plan with, select, and process various materials in a manner consistent with safe industrial practice. The student will use critical thinking in the planning and selection of materials and in the methods used to work with them.***
8. Metallurgy	Understanding the working characteristics of materials has become increasingly more important to manufacturing in the past two decades. To better understand and work with the materials in use today, it is essential to be familiar with the properties of these materials and the changes that occur when they are exposed to heat and cold. *Standard* ***The student will develop and demonstrate a basic understanding of the physical properties of metals, their chemical compositions and classifications, and the heat treatment processes used to change their characteristics.***
9. Welding—Fuel/Oxygen and Electric	According to the American Welding Society, there are 39 welding processes applied as a joining technique both for fabrication in production and for repairs. The ability to identify and apply various procedures is fundamental in welding practices. *Standard* ***The student will have the ability to select, identify, and apply various processes in a given requirement, consistent with approved practices.***
10. Soldering/Brazing	Soldering and brazing processes are basic joining procedures in the manufacturing, electronic, and construction fields, making a working knowledge of these skills and their application essential. *Standard* ***The student will apply and identify these processes according to approved procedures. Included in these practices is the ability to identify the fluxes, solders, and materials that are used in varied applications.***
11. Fastening—Bonding/Chemical	Structural (load-bearing) and nonstructural polymer adhesive bonding is widely used in the manufacturing industry. Proficiency in the use

11. Fastening—Bonding/Chemical *(Continued)*

and application of these processes is vital in diverse settings and is basic to the manufacturing industry.

Standard The student will learn chemical bonding, understand its importance, and demonstrate the ability to use the appropriate technique and procedure.

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12. Mechanical Fastening

Knowledge of mechanical fastening is an essential requirement of the manufacturing industry. The application of the numerous fastening devices requires knowledge of specific requirements in deciding which type of fastener is appropriate.

Standard The student will evaluate, identify, and use the appropriate fastener for various applications.

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13. Threads and Thread Cutting

The use of taps and dies for producing internal and external threads is basic to many facets of manufacturing and is an essential part of manufacturing technology.

Standard The student will display working knowledge and skill in the use of taps and dies and will use charts to determine tap drill sizes, body clearance, and thread fits.

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14. Metal Finishing

Metal finishing is an important process in the manufacturing industry because many products require additional surface treatment. Such treatments are applied for appearance, protection, identification, and cost reduction.

Standard The student will understand the rationale for applying a finish and will learn that metal finishing is the depositing of material or the removing of material, depending on which procedure enhances the product.

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15. Drilling

Drilling is a basic process in the manufacturing area during which a rotating tool is fed into the material to make a hole. The hole allows for other material removal processes to be performed, such as reaming, countersinking, counterboring, tapping, spot-facing, and boring.

Standard The student will understand the importance of drilling tools and equipment; identify different types of twist drills; demonstrate good safety practices when operating a drill press; select the proper cutting speeds and feeds for the size of the drill and the type of material being drilled; prepare a setup on the drill press, using the work-holding devices, and operate the drill press; and understand the sequential steps of reaming, countersinking, tapping, or boring after drilling a hole.

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16. Filing

Filing is an efficient hand process for removing metallic and nonmetallic materials. When metal is filed to shape and size, the surface finish can be improved.

Standard The student will know and understand how files are used to shape and improve the surface finishes of metallic and nonmetallic materials and will be able to select the correct files for specific applications.

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17. Sawing

Sawing, which is used to cut materials from large sections into smaller sections, is a basic process of manufacturing. Sawing is also used to make various shapes, angles, and slots and to cut radii in materials.

Standard The student will understand the importance of sawing in manufacturing and will explain the purpose of various tools and machines used for sawing. The student will correctly demonstrate the use of a hand hacksaw and power saw in cutting material clamped in a vise.

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18. Turning

Turning is a basic process used in almost all manufacturing. Knowledge of turning methods in this era of high technology is required of those interested in fields related to machine operation, tool design, quality assurance planning, programming, and industrial and mechanical engineering.

Standard The student will identify and use different types of turning machines, including the computerized numerically controlled (CNC) lathe.

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19. Grinding

High technology, new materials, surface finish, and new accuracy requirements have made grinding an important link in the manufacturing industry. Entry-level jobs in the industry require knowledge of grinding procedures and the ability to design and engineer machine parts.

Standard The student will gain knowledge of modern processes and methods used both nationally and internationally in the field of grinding and will develop the ability to use grinding equipment.

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20. Milling

Milling is an important basic material-removal process. The manufacturing industry expects employees to have an understanding of milling before becoming involved in the fields related to quality assurance, planning, tool design, machine operation, programming, or mechanical or industrial engineering.

Standard The student will identify and safely use various types of milling machines, including computerized numerically controlled (CNC) milling machines and mill cutters. The student will calculate

20. Milling *(Continued)*	*feed and speed for different size cutters and types of materials and select the proper cutting agent for the job.*
21. Flame/Arc Cutting	High technology has created uses for gas flames and electric arcs in the manufacturing and construction industries. Knowledge of this technology and the ability to use these methods are required by industries and engineering firms. *Standard The student will gain knowledge of flame/arc cutting methods used in the manufacturing and construction industries and demonstrate the ability to safely set up and use flame and arc cutting equipment.*
22. Industrial Forming Processes—Casting	Metal casting is one of the world's basic industries. Metal-casting methods are frequently the most direct route from raw material to finished product at the least cost. The recycling of scrap metal is a source of much of the raw material used in foundries. *Standard The student will prepare green sand molds, study various methods of pattern making, and acquire knowledge of the metal casting industry.*
23. Industrial Forming Processes—Forging	The shaping of hot metal by means of impact or pressure is used to produce parts that are very strong. Because forging results in high-quality, accurate products with little waste, it is a critical part of manufacturing technology. *Standard The student will learn techniques used to transform stock into usable goods. Since forging is a basic manufacturing process, the student will understand the importance of these techniques and become adept in their use.*
24. Industrial Forming Processes—Sheet Metal Fabrication	Such commonplace sheet metal products as roofing, siding, bins, and air-conditioning and heating ducts are manufactured via the technologies of commercial sheet metal fabrication. Precision sheet metal work is widely used in the aerospace industry. *Standard The student will gain knowledge and skill in the basic processes of sheet metal work to produce cylindrical, angular, and conical shapes.*
25. Industrial Forming Processes—Cold Working	Cold working of metals is the preferred method in many applications because it costs less, is accurate, and results in a good surface finish. Straight bends or compound curves done by impact or pressure require a working knowledge of fundamental processes in the manufacturing system.

25. Industrial Forming Processes—Cold Working *(Continued)*	***Standard** The student will learn many techniques of cold working that can be used to change the shape and form of metal. The student will understand the importance of these techniques and will become skilled in their applications.*
26. Industrial Forming Processes—Shearing	Separation processes that do not remove material in the form of chips are widely employed in conjunction with other cold working methods. Shearing is frequently used in preparing stock for further processing or as a means of separating waste stock after other forming processes have been employed. ***Standard** The student will understand that when the force of a cutting tool exceeds the strength of the material at the shear plane, severance takes place. This principle can be used in cutting stock to the appropriate size or shape for further fabrication or in removing waste stock from a fabricated part.*
27. Computer-Aided Manufacturing	There is a need to develop a knowledge of how computers are used to control tools and machines in the manufacturing industry. The ability to understand, analyze, program, and direct machines controlled by computers is important to those entering the manufacturing industry. ***Standard** The student will take written instructions and convert them to a language that can be understood by the computer.*
28. Computer-Integrated Manufacturing	There is a need to gain understanding of how computers can be used to integrate all business and manufacturing functions in an industrial environment into a computerized network. ***Standard** The student will understand the role that computers play in modern manufacturing.*
29. High Technology Industrial Processes	A fundamental knowledge of the high technology processes used in manufacturing is necessary to understand the importance of technology in our society. ***Standard** The student will know the importance and use of the new technology in the manufacturing environment. The student will also be able to explain and discuss the new processes and the situations in which they could be applied.*
30. Computer-Aided Design and Drafting	Knowledge of computer-aided design and drafting has become fundamental in every field that creates structures or hardware products from raw materials. Electronic images are more efficient from the standpoint of design decisions, revision, storage, reproduction, and transportability.

30. Computer-Aided Design and Drafting *(Continued)*

Standard The student will gain an understanding and appreciation of the increased productivity and greater accuracy made possible through the application of computer-aided design and drafting.

31. Flexible Manufacturing Systems

Work cell designs and flexible systems for materials handling are being implemented and are creating a more efficient flow of mixed products. Thus, knowledge of these systems is important to people entering the field.

Standard The student will understand the value of machine clustering, robotic materials, handling procedures, family-of-parts concepts, and just-in-time inventory. The student will also gain an understanding of theoretical and practical problem solving.

32. Career Guidance

A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering.

Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.

33. Gender Equity

A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today.

Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.

34. Leadership

All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary to relate successfully to society.

Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the use of the democratic process.

1. Cutting Action Theory	**The major types of cutting tools used to separate metal into parts are slicing tools, wedging tools, and scraping tools. Since the cutting tools produce chips of various sizes and shapes, the machinist must determine which cutting tool has the proper characteristics for cutting a given material.** ***Standard The student will understand the theory of cutting (when the force of the tool exceeds the strength of the material at the shear plane, rupture or slippage of the grain structure occurs, thus forming the metal chip). The student will utilize this theory in the selection and use of the proper cutting tool for the material to be machined and the part to be manufactured.***
2. Cutting Tool Materials	Metal-cutting tools must possess a variety of properties so that different materials may be cut under varying conditions. The major properties of cutting tools are hardness at high temperatures, wear resistance, and strength. Knowledge of these properties is of importance to the machinist in tool selection and part production. *Standard The student will understand the properties of cutting tool materials and the vital part they play in the entire manufacturing process.*
3. Linear Measurement	Knowledge of measurement systems that are used in the manufacture of products is a basic skill of the machinist. The ability of the machinist to use accurate measurement allows for quality part production. *Standard The student will understand the importance of measurement systems and be able to measure accurately, using the English system and the metric system.*
4. Materials Testing	Mechanical testing is commonly used in the process of material evaluation. Proper testing methods enable various design features of a product to be evaluated as they relate to machining procedures. *Standard The student will know the fundamental methods used to test materials and will understand why materials are tested and how these factors contribute to a product's design.*
5. Metal Finishing—Mechanical	The product's finish and its attractiveness to the customer are two of the most important factors in determining whether or not the product will sell. Finish is also an indicator of the quality of work. A number of different manufacturing processes are required to create the required surface finishes. *Standard The student will understand the various mechanical metal finishing processes (cleaning, honing, lapping, belt/disk grinding, barrel tumbling, polishing, buffer/power brushing) as they relate to the production of a marketable product.*

6. Properties of Metals	Materials are selected on the basis of their properties or characteristics and the required uses. Knowledge of various metal products is important for workers engaged in the design, fabrication, and maintenance of metal products. *Standard The student will study and understand the relationship of the design of a product to the inherent properties of metals considered for its use (weight, hardness, toughness, brittleness, corrosion resistance, response to heat treatment, and malleability).*
7. Semiprecision Measuring Tools	Knowledge of semiprecision measuring tools and their use in the manufacture of products is of fundamental importance to the machinist. The ability of the machinist to select and properly use these tools allows for quality part production. *Standard The student will use semiprecision tools, such as a steel rule, screw pitch gauge, center gauge, drill-point grinding gauge, combination set, and calipers, as needed in the manufacture of products.*
8. Precision Measuring Tools	Knowledge of precision measuring tools and their use in industry is of primary importance to the machinist. Parts used in high technology components require tolerances that must be maintained by precision measurement. *Standard The student will use precision measuring tools (micrometer, vernier/dial caliper, vernier/dial height gauge, dial indicator, gauges, sine bar, digital readout) as needed in the manufacture of products.*
9. Print Reading	Print reading requires the ability to "see" a mental image of the part or object that is drawn, as well as all the information for machining and/or assembling the object. *Standard The student will understand the graphic language on the print (line types, symbols, dimensioning, views of objects, angular and linear tolerances, tooling points, composition of materials, and title block information).*
10. Quality Control and Inspection	The inspection and testing of a part is very important during its manufacturing cycle. The machinist must perform continuous on-line inspections to ensure that parts meet print specifications. *Standard The student will identify the needs and components of a modern quality control/inspection facility and will concentrate on inspection procedures during production.*

11. Abrasive Machining and Grinding	**Abrasive machining and grinding are metal removal processes used for rapid removal as well as finishing operations on castings, forgings, welds, bar stock, and hardened parts.** *Standard The student will be able to identify, select, and demonstrate the principles, equipment, and operation of abrasive machining/grinding machines and abrasives.*
12. Abrasive Machining and Grinding—Abrasives	Abrasives are used as cutting tools or cutting material in the form of wheels, sheets, sticks, and pastes in every area of the machining trades. Selection of the proper abrasive is an important component in the manufacturing cycle of a product. *Standard The student will select, identify, and recommend the principal types of abrasives, grain bondings, proper wheel shape, and composition for a given grinding operation.*
13. Abrasive Machining/Grinding—Equipment	Abrasive machining/grinding equipment includes precision tools used for rapid material removal, very close tolerances, and high-quality finishes on flat, cylindrical, tapered, and irregular surfaces after initial machining of the part. The proper grinding machine must be used to complete the part. *Standard The student will identify, select, set up, and operate in a safe and productive manner typical abrasive machining/grinding equipment, including offhand grinders, portable grinders, surface grinders, outside diameter/inside diameter (OD/ID) grinders, tool and cutter grinders, honing machines, vibrating tumblers, and lapping machines.*
14. Computer Numerical Control/Numerical Control—Robotics	Computer numerical control (CNC) is the most significant breakthrough in manufacturing processes since the invention of the production-line technique to mass-produce identical interchangeable parts. The field of CNC/NC machining technology is constantly expanding. *Standard The student will summarize the advantages, disadvantages, purposes, applications, and safety practices of basic CNC/NC technology.*
15. Computer Numerical Control/Numerical Control—Controls	The machine and its control unit, directed by the programmer, perform many of the functions previously carried out by multiple operations and setups. CNC/NC controls allow efficient production of complex products once thought impossible to manufacture. *Standard The student will explain, understand, and describe how computer numerical control/numerical control systems collect, process, and execute information.*

16. Computer Numerical Control/Numerical Control—Basic Programming	Information required to operate the control system and the machine tool must be transcribed from a print onto an input medium. Basic programming requires the knowledge of conventional machine tools, computer-controlled machine tool practices, machine command codes, and data-entry skills (keyboarding, data storage, and retrieval). *Standard The student will manually program a simple part for a CNC/NC machine tool, transcribing all necessary print information, machine codes, and other instructions necessary to manufacture the part.*
17. Computer Numerical Control/Numerical Control—Machine Tools	The use of programmable automation to manufacture a product more economically and with improved quality has become a driving force in the free enterprise system. Programmable automation has been adapted to the operation of most metalworking machines, thus requiring that workers be familiar with these high-technology systems. *Standard The student will identify, select, and demonstrate the principles, equipment components, and safe operation of a CNC/NC lathe and/or milling machine.*
18. Cutting Fluids	Cutting fluids prolong tool life, increase the rate of metal removal, aid in producing a finer finish, and enable machining at closer tolerances. In order to select the proper cutting fluid for a particular machining application, the operator must understand the purposes, properties, classifications, and safe use of cutting fluids. *Standard The student will understand the purposes, properties, classifications, and safe use of cutting fluids while selecting the proper cutting fluid for a specific machining application.*
19. Cutting Fluids—Categories	Cutting fluids are available under different trade names, many of which give no true indication of their composition or function. Proper identification of cutting fluids is required for the safe and legal disposition of these potentially hazardous wastes. *Standard The student will identify and categorize commercial cutting fluids based on sight, smell, feel, color, final application, and method(s) of mixing the cutting fluid and will know the proper disposal method for each type of cutting fluid.*
20. Cutting Fluids—Selection	The selection of a cutting fluid is determined by the malleability of the material, the type and severity of the operation being performed, and the operating conditions. *Standard The student will use the principles of the malleability rating of the metal, the severity of the operation being performed, and the operating conditions as guides in the selection of cutting fluids.*

21. Drill Press	The drill press is one of the most common of the machine tools. It is used to drill holes and accomplish other hole-machining operations (e.g., center drilling, reaming, boring, counterboring, countersinking, and tapping). Understanding the operation of the drill press is basic in the manufacturing process. *Standard The student will safely set up and operate the appropriate drill press for the manufacture of a desired product.*
22. Twist Drill	A common cutting tool is the twist drill, which is rotary-ended with two or more lips and straight or helical flutes. Knowledge of the use of this cutting tool is important in meeting industry requirements for drilled holes in products. *Standard The student will be knowledgeable in twist drill nomenclature, size classification, drill (angle) geometry, and drill grinding procedures.*
23. Industrial Materials	Knowledge of materials is a fundamental requirement of the manufacturing industry. The ability to identify, analyze, and apply various materials in diverse settings is essential to meet products' requirements. *Standard The student will be able to select and apply appropriate materials in various situations consistent with approved practices.*
24. Industrial Materials—Ferrous	Ferrous materials (containing iron) are evident in many products in the industrial world. A basic knowledge of ferrous alloys and their properties is important for workers in the design, fabrication, and maintenance of metal products. *Standard The student will select, identify, and classify ferrous alloys. Applications will reflect the physical and mechanical properties required of the product.*
25. Industrial Materials—Nonferrous	Nonferrous (containing no iron) materials are evident in many products in the industrial world. A basic knowledge of nonferrous alloys and their properties is important for workers in the design, fabrication, and maintenance of metal products. *Standard The student will select, identify, and classify nonferrous alloys. Applications will reflect the physical and mechanical properties required of the product.*
26. Industrial Materials—Nonmetallic	The ability to identify, analyze, and apply various nonmetallic materials is a basic skill for workers engaged in the design, fabrication, and maintenance of industrial products.

26. Industrial Materials—Nonmetallic *(Continued)*	*Standard The student will select, identify, and classify nonmetallic materials. Applications will reflect the physical and mechanical properties required of the product.*
27. Industrial Materials—Heat Treating	In order to increase the mechanical and physical properties of ferrous and nonferrous alloys, specialized treatments are used that include the application of heat. *Standard The student will describe and apply the basic principles of hardening, quenching, tempering, annealing, normalizing, and stress-relieving ferrous and nonferrous materials.*
28. Industrial Materials—Hardness Testing	Heat treaters, inspectors, quality control workers, and metallurgists use hardness testing equipment to test a material's resistance to penetration and permanent deformation. *Standard The student will determine the method to be used for hardness testing and will safely perform tests, including the calculation of tensile strength based on the test results.*
29. Lathe	The lathe is thought to be one of the first machines invented by human beings. The large number of operations the lathe can perform makes it one of the most useful and necessary machine tools. Lathes are built primarily for making cylindrical and conical parts (pins, shafts, bolts, and pulleys) and for boring large holes. An understanding of the metalworking lathe and its operation is essential to the student's development of a broad knowledge of machine shop theory and practice. *Standard The student will categorize lathe types and classify them as to their effectiveness in various product manufacturing situations.*
30. Lathe—Line of Power	The major purpose of the lathe is to change the shape of metal by rotating a work piece against a cutting tool. The components serve one of three primary functions: driving the lathe, holding and rotating work, or holding and moving tools. Understanding the major components and their purposes is essential in the successful operation of the lathe. *Standard The student will understand the lathe drive line (switch, motor, belt and pulley system, headstock, gear train, quick change gear box, lead screw, and carriage). The student will demonstrate the ability to set up and manipulate these components.*
31. Lathe—Work-Holding Devices and Accessories	Numerous accessories and work-holding devices must be used in proper relation to one another to accomplish the desired lathe operation. Knowledge of work-holding devices and lathe accessories is a

31. Lathe—Work-Holding Devices and Accessories *(Continued)*	**fundamental requirement for the manufacture of parts and for safe operation of the lathe.** ***Standard The student will understand the work-holding devices and accessories (i.e., centers, chucks, collets, tool holders, dogs, drive/face plates, steady rests, taper attachments) commonly used in the setup and operation of a lathe.***
32. Lathe—Cutting Tools	**Cutting tools are designed in many different shapes for special purposes. For efficient machining on a lathe, the correct tool bit and cutter material must be selected and the tools must be used properly.** ***Standard The student will use the various cutting tools and tool holders (e.g., turning, facing, threading, boring tools).***
33. Lathe—Work Processes/ Operations	**Machined parts are manufactured in a given sequence. On the lathe, operations fall into two general classifications: (1) external operations (facing, turning, knurling, threading, etc.); and (2) internal operations (drilling, boring, threading, etc.). The lathe operator must rely on his or her knowledge of the lathe's major parts and their functions in order to set up the machine properly.** *Standard The student will select the proper lathe process and set up the lathe to achieve the desired part configuration.*
34. Lathe—Speeds and Feeds	One of the technical aspects of operating a turning machine properly and efficiently is to calculate or determine the proper cutting speed, feed, and depth of cut. *Standard The student will determine the cutting speed and feed rate through mathematical calculations and will use the determined speeds and feeds to set up the lathe for optimal cutting efficiency.*
35. Layout	Layout is the process of making lines, circles, and arcs on various materials to indicate the shape and size of a part prior to machining. All manufactured parts must be made to a size and shape specified by the designer. *Standard The student will apply the rationale and principles of layout techniques prior to machining a part.*
36. Layout—Procedures	The ability to use a systematic approach to the translation of print dimensions into layout lines as applied to a product prior to manufacture is a basic skill of the precision machining trades. *Standard The student will translate print dimensions into the layout of a finished part, using the English or metric system of measurement.*

37. Layout—Equipment

Knowledge of layout equipment is a basic requirement for precision machining, inspection and quality control. The ability to identify, use, and operate semiprecision/precision layout tools is a basic skill.

Standard The student will identify and use the tools and equipment needed to translate print dimensions into a finished layout.

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38. Layout—Semiprecision

Selecting and using the proper tool for the type of layout required is basic to the completion of a layout prior to machining.

Standard The student will identify, select, and demonstrate the proper use of semiprecision layout tools (e.g., combination set, rules, surface gauge, dividers) to transfer print dimensions to materials prior to machining.

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39. Layout—Precision

Precision layout is fundamental to all levels of the machining trade. Complex products manufactured from various materials require a planned and precise transfer of print information and tolerance machining, including the use of height gauges, dial indicators, and gauge blocks.

Standard The student will identify and use the proper precision layout tools for transferring print dimensions to various materials prior to machining.

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40. Milling Machine

Milling is the process of shaping surfaces, using rotary cutters with single or multiple teeth. The selection of the proper milling machine is an essential skill. The selection is governed by the configuration specifications of the part to be machined.

Standard The student will identify, classify, justify, set up, and operate milling machines in a safe and productive manner to manufacture a product.

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41. Milling Machine—Line of Power

The milling machine is a fundamental machine tool used in the modern machine shop. An understanding of the line of power and function of each component is necessary for the safe and productive use of the milling machine.

Standard The student will be able to identify and describe the functions of components of each of the representative classifications of milling machines.

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42. Milling Machine—Work Holding

Planning the basic setup for holding work on a mill is an essential requirement of the milling machine operator.

137

42. Milling Machine—Work Holding *(Continued)*	*Standard The student will understand the basic setups for holding work and the safety elements required to protect the operator during the milling operation.*
43. Milling Machine—Work Processes	The planning of machining sequences, setups, and operations to be performed must be accomplished in a cost-effective and safe manner. Machining may involve flat surfaces, slots, grooves, steps, holes, circular features, and gears, any of which may require special attachments. *Standard The student will identify, set up, and perform basic and complex milling machine operations (squaring, slotting, grooving, stepping, boring, drilling, indexing, and gear cutting) and will use special attachments if necessary.*
44. Milling Machine—Speeds/Feeds	The ability to produce a work piece in the shortest possible time while maintaining cost-effective cutter life and the desired surface finish is a key to the manufacturability of the product. *Standard The student will calculate the speeds and feeds for any milling cutter classification and type.*
45. Nonconventional Machining	The advancement of technology has increased the demand for more intricate designs, smaller tolerances, and products made of exotic materials; thus, a knowledge of when to apply nonconventional machining practices is required. *Standard The student will be knowledgeable of high-technology nonconventional machining processes (i.e., electrical discharge machining, electrochemical machining, chemical machining, ultrasonic machining, electron-beam machining, and laser beam machining) and their applications in the machining of exotic materials.*
46. Stock Cutoff Machines	Saws are used to cut standard materials to workable lengths. Straight square cuts on a wide variety of materials must be made quickly and accurately. This is the fundamental process in material preparation for use in machine tools. *Standard The student will successfully operate the following cutoff machines: power hacksaws, horizontal and vertical band saws, cold saws, and abrasive cutoff saws.*
47. Technical Mathematics	A working knowledge of mathematics and problem-solving techniques makes it possible to compute required dimensions and other essential data that are applied on the job and in everyday living. *Standard The student will be able to calculate, compute, estimate, graph, tabulate, and demonstrate a working knowledge of fractions,*

47. Technical Mathematics (Continued)	*decimals, formulas, algebra, and angular measurements as used in trigonometry and geometry. The student will be able to read and use graphs, charts, and tables.*
48. Technical Mathematics—Fractions and Decimals	A working knowledge of fractions and decimals is essential and basic to the solution of practical problems and to the correct use of measuring tools and machine tools encountered in the machining trades. *Standard The student will calculate, compute, estimate, graph, tabulate, and demonstrate a working knowledge of the principles and applications of fractions and decimals.*
49. Technical Mathematics—Formulas/Algebra	Many solutions to simple and complex machining problems are based on the application of formulas found in reference manuals or handbooks. The solutions require the ability to perform algebraic manipulations of the formula elements. *Standard The student will analyze a practical problem, extract the essential data, select the proper formulas, and compute the solution.*
50. Technical Mathematics—Geometry	Layout procedures prior to machining require the construction of lines, arcs, circles, and polygons. The ability to transfer print data while applying the concepts of geometric construction is a basic and essential component of the machining trades. *Standard The student will evaluate a practical problem and apply the concepts of geometric construction to obtain the proper solution.*
51. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering. *Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.*
52. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. *Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*

53. Leadership

All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society.

Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.

1. Safety	Safety is a fundamental part of a manufacturing technology program. Individuals working with plastics must know how to use hand tools properly and safely, how to operate power equipment properly and safely, and how to use the many resins and chemicals necessary to make a plastic product. *Standard The student will know and understand the importance of good safety practices in both the school shop and industrial shop settings and will understand how working safely affects him or her on and off the job.*
2. Plastic Process Introduction	There are many processing methods using a variety of materials that go into the manufacture of a plastic product. A thorough understanding of these processes and the proper handling of the materials is necessary for the plastics parts fabricator. *Standard Through the use of the materials and production equipment used to make plastic products, the student will understand the difference between thermoset and thermoplastic materials and the importance that time, temperature, and pressure play in the manufacturing process.*
3. Molding Processes	The majority of plastic products made in the world are manufactured by one or more of several molding processes. The plastics parts fabricator should have a general working knowledge of these processes. *Standard The student will be exposed to as many of the molding processes as possible, including injection, compression, transfer, rotational, blow, extrusion, calendering, high pressure laminating, and cold molding.*
4. Reinforcement Processes	There are many plastic products made in which a reinforcement material is used with the resin, and a working knowledge of the plastic reinforcement processes is important. *Standard The student will be exposed to as many of the reinforcement processes as possible, including vacuum bagging, pressure bagging, filament winding, premix matched molding, and resin transfer molding.*
5. Thermoforming Processes	There are many products and packaging materials produced by thermoforming processes, making a working knowledge of these processes important to a person entering the plastics field. *Standard The student will be exposed to as many of the thermoforming processes as possible, including mechanical thermoforming, vacuum forming, blow forming, heat sealing, and matched mold forming.*

6. Nonmetallic Casting Processes	Knowledge of the variety of plastic resins and their additives, and familiarity with processing methods, are important aspects of the plastics industry. *Standard The student will be exposed to as many of the casting processes as possible, including simple casting, embedment, potting, encapsulation, plastisol casting (i.e., slush and dip), and cultured marble casting.*
7. Foaming Processes	The use of urethane foam and other foamed plastic resins is increasing, making a thorough understanding of the products and processing methods vital to a person entering the field. *Standard The student will be exposed to as many of the foam processes as possible, including foam in mold applications, expandable polystyrene bead applications, and other foamed plastics and their uses.*
8. Mold Preparation	The successful manufacture of a plastic product begins with the proper preparation of the mold from which it is made. The ability to identify the type of mold, the proper release agent for the mold, and how to properly apply it are important to the successful production of the part. *Standard The student will know how to identify molds, prepare seasoned molds for part production, and prepare new molds for part production.*
9. Plastic Material Identification	The inspection and identification of plastic resins and related processing materials is important to the parts fabricator. Knowledge or lack of knowledge in this area can determine success or failure in the given production process. *Standard The student will understand the importance of plastic manufacturing materials and will be able to select and apply those materials in various requirements consistent with approved practices.*
10. Repair of Plastic Materials	Knowledge of plastic repair techniques is not only necessary for fixing used or damaged products but is also necessary for the repair of tooling and new products that are damaged during production. *Standard The student will learn about the equipment, materials, and techniques used to repair a variety of plastic products.*
11. Nonmetallic Bonding Methods	The fabrication of a plastic product in many cases involves the joining together of two or more pieces to make the finished item. A familiarity with the methods used in these processes is necessary for the plastic-parts fabricator.

11. Nonmetallic Bonding Methods *(Continued)*	*Standard The student will learn the various bonding techniques currently used in the industry and be able to determine the methods suitable for the products being manufactured.*
12. Mass Production	Products in the school or home workshop are usually made one at a time. In industry, however, production numbers more often than not reach into thousands of units. Knowledge of techniques used to mass produce products and an understanding of standard business practices is cf great importance to the production worker. *Standard The student will take part in a group effort to design, manufacture, and market a product for profit, using mass production techniques and methods. This process will bring about a clearer understanding of the techniques used for multiple production of a product and the interpersonal relationships necessary to operate a successful business.*
13. Tooling for Plastics	A mastery of parts manufacture, as well as comprehension of the design and manufacture of molds and related hardware associated with plastic products, is critical in today's industry. *Standard The student will learn how to transform ideas on paper into finished products, using design principles and techniques taught in the process of tooling for plastic products.*
14. Advanced Composites	The aerospace industry has been pioneering the use of advanced composite plastic materials for years. These materials and processing techniques represent another plateau of learning for the plastic-parts fabricator. *Standard The student will be introduced to the planning process, the types of composites, and the support materials necessary to produce an advanced composite structure. This knowledge will then be applied to the construction of advanced composite parts.*
15. Print Reading	Before production can begin on a product, there must be a thorough understanding of the task. This knowledge is obtained, in part, by reading the engineering drawing or print. Comprehension of the material is critical to avoid mistakes and to ensure the successful completion of the task. *Standard The student will understand the importance of the print as it relates to parts production and will interpret the print to extract the information necessary to manufacture the product.*
16. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed

16. Career Guidance *(Continued)*	to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering. *Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.*
17. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. *Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
18. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society. *Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*

1. Safety	The knowledge and practice of safety procedures is a fundamental requirement for the manufacturing technology cluster. The ability to understand procedures, hazards, and OSHA standards is required for working in a safe environment. Standard *The student will understand the importance of safety as related to the specific skill area. He or she will be able to practice, recognize, and implement current OSHA standards.*
2. Joint Preparation	The knowledge of weld joints and their preparation is a fundamental requirement in the welding and fabrication industry. The ability to identify, analyze, and apply the various joints to specific applications is a basic skill. Standard *The student will understand the importance of weld joints and their application. He or she will be able to select and apply the correct joint and joint preparation for the various requirements, consistent with approved fabrication and structural codes.*
3. Welding Materials	A knowledge of welding materials is a fundamental requirement in the welding industry. The ability to identify, analyze, and apply various materials to diverse applications is a basic requirement in the manufacturing process. Standard *The student will be able to select and apply appropriate welding materials in various requirements, consistent with approved practices.*
4. Welding Positions	A knowledge of the positions used in welding is a requirement of the welder. The ability to know and apply the various techniques to each position is critical to sound and cost-effective welds. Standard *The student will understand the importance of welding positions and their applications and will be able to select and apply the correct welding positions and techniques to each activity.*
5. Welding—Electrodes and Filler Metal	A knowledge of arc welding electrodes is a fundamental requirement in the welding industry. The ability to identify, analyze, and apply the various electrodes and filler metals to specific applications is a basic requirement. Standard *The student will be able to select and apply the correct electrode and filler metal for the various requirements, consistent with approved fabrication and structural processes.*
6. Shielded Metal Arc Welding (SMAW)—Equipment	A knowledge of arc welding equipment is a fundamental requirement in the welding industry, and the ability to use the welding equipment and to analyze possible problems is a basic requirement.

6. Shielded Metal Arc Welding (SMAW)—Equipment *(Continued)*

Standard The student will understand arc welding equipment and will be able to select and apply the correct tools and equipment to the various welding requirements, consistent with approved practices. He or she will also be able to analyze equipment problems.

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7. Shielded Metal Arc Welding (SMAW)—Techniques

A knowledge of arc welding techniques is a fundamental requirement in welding. The ability to identify, analyze, and apply various techniques to diverse applications is a basic requirement in the welding process.

Standard The student will understand the various welding techniques and will be able to select and apply those techniques that meet requirements, consistent with approved practices.

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8. Oxygen Acetylene Welding (OAW)—Cutting

A knowledge of cutting metals using the fuel/oxygen process is a fundamental requirement in the welding industry. The ability to identify, analyze, and apply the cutting process to specific applications is a basic requirement in the fabrication processes.

Standard The student will understand the process of cutting with fuel/oxygen and its application and will be able to select and apply the correct cutting procedures to the various requirements, consistent with approved practices.

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9. Oxygen Acetylene Welding (OAW)—Equipment

A knowledge of fuel/oxygen welding equipment and the ability to properly use that equipment is a fundamental requirement in the welding industry.

Standard The student will understand the proper use of the welding equipment and will be able to select the correct tools and equipment and apply them to each welding activity.

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10. Oxygen Acetylene Welding (OAW)—Techniques

A knowledge of fuel/oxygen welding techniques is a fundamental requirement in the welding industry. The ability to identify, analyze, and apply the various techniques to diverse applications is a basic requirement in the welding process.

Standard The student will understand the various oxygen acetylene welding techniques and will be able to select and apply those techniques that meet the requirements, consistent with approved practices.

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11. Gas Tungsten Arc Welding (GTAW)—Equipment

A knowledge of GTAW equipment and how to set it up and operate it is vital for producing quality welds.

Standard The student will understand the functions of all controls on GTAW equipment and be able to manipulate them in such a way as to produce quality welds.

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12. Gas Tungsten Arc Welding (GTAW)—Manipulation	Proper manipulation of the torch is essential for the production of consistently even weld beads. *Standard The student will understand torch angles and filler rod manipulation and their relation to weld position and the type of joint being used.*
13. Gas Tungsten Arc Welding (GTAW)—Electrode Selection, Shielding Gas Selection	Proper electrode and shielding gas selection are basic skills and must be considered in the production of quality welds. The ability to apply various electrodes and gases to different materials and joints is basic to the manufacturing system. *Standard The student will understand the importance of electrodes and shielding gases and will be able to select and apply those materials in various requirements, consistent with approved practices.*
14. Gas Metal Arc Wel'ing (GMAW)—Wire Selection, Shielding Gas Selection	Proper electrode and shielding gas selection are important factors to be considered in the production of quality weld beads. The ability to apply various electrodes and gases to different materials and joints is basic to the mar.ufacturing system. *Standard The student will understand the importance of electrodes and shielding gases and will be able to select and apply these materials in various requirements, consistent with approved practices.*
15. Gas Metal Arc Welding (GMAW)—Manipulation	Proper manipulation of the GMAW welding gun is essential for the production of consistently even weld beads. *Standard The student will understand the importance of gun angles in relationship to the weld position and the type of joint being used and be able to properly manipulate the welding gun.*
16. Gas Metal Arc Welding (GMAW)—Equipment	A knowledge of how to set up and operate GMAW equipment is vital for producing quality welds. *Standard The student will understand the functions of all controls on GMAW equipment and be able manipulate them to produce quality welds.*
17. Testing and Inspection	The testing and inspection of finished welds is a vital part of any manufacturing system that uses welding. *Standard The student will understand the importance of the visual inspection of completed welds and will learn the various testing methods used in the industry to certify sound welds.*

18. Print Reading	A Fundamental knowledge of blueprint reading is essential for entry level welders. The ability to assemble parts from drawings and sketches is vital to the manufacturing system. *Standard The student will understand the importance of blueprint reading and will apply the skills required to assemble parts.*
19. Other Welding Processes	A knowledge of specialized welding processes other than GMAW, GTAW, SMAW, and OAW/C can aid in job advancement. The ability to identify and apply the various processes to a specific application is important in the industry. *Standard The student will understand the importance of other welding processes and their applications and will select and apply the correct process to the proper welding or cutting operation, consistent with approved practices.*
20. Distortion in Fabrication and Its Control	The manufacturing industry requires that its workers understand expansion and contraction as encountered in the fabrication of metallic and nonmetallic parts. *Standard The student will understand the coefficient of expansion for various materials and will apply correct procedures in the control of distortion in product fabrication.*
21. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering. *Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational preparation goals; and in expanding their individual options.*
22. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. *Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
23. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, commu-

23. Leadership *(Continued)*	nication, business meeting, and personal business skills necessary for relating successfully to society. *Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*

Manufacturing technology standards integrate academic core skills, including:

Language Arts

- Reading written directions and technical instruction manuals
- Increasing listening skills through verbal instruction, demonstrations, and student interaction
- Expanding technical terminology and vocabulary
- Developing writing and oral presentation style
- Interpreting technical data from charts and tables
- Interpreting mathematical word problems for potential solution
- Researching job information and sharing data through written and oral presentation
- Interpreting and completing an employment application

Mathematics

- Reinforcing basic mathematical concepts, skills, and problem solving in measurement, geometry, number patterns, and functions
- Interpreting scales and gauges on equipment for safe setup and operation
- Maintaining a record-keeping system to compute profit and loss, inventory, and production costs
- Calculating heat-treating temperature and exposure, graphing time versus temperature reading
- Using problem-solving and critical-thinking skills to solve stress formulas and determine tensile strength
- Computing problems involving ratio and proportion, parallel and radial line development, and triangulation
- Using mathematical concepts, problem solving, and critical-thinking skills while using precision measuring tools
- Calculating bend, seam, and angle allowances

Science

- Understanding the environmental problems of industry and the chemical composition of materials
- Understanding the processing of various raw materials: ferrous and nonferrous, metallic and nonmetallic
- Understanding physical and chemical properties of metals and the reaction of metals to heat and cold
- Applying scientific principles; understanding kinetic molecular theory, metallurgy, and metal structure
- Observing reactions of capillary attraction, oxidation, diffusion, and adhesion in the given process
- Understanding adhesive thermo and thermosetting plastic
- Understanding the hardness and composition of abrasive materials and the cutting action of natural and manufactured abrasives
- Understanding the effect of a flame on ferrous and nonferrous material
- Understanding types of sheet metal, their coatings, corrosion factors, and working characteristics

- Understanding interface devices used between the computer and industrial machines and how both binary and ASCII data are transferred and stored
- Understanding fluid power concepts of end effector design and holding devices
- Applying theories of physical science; understanding force, its effects on matter, and the crystalline structure in metals
- Understanding the relationship of cutting speeds and malleability, cutting tool geometry, work hardness, material classification, and heat transfer
- Relating the principles of mechanics to micrometers, height gauges, sine bars, dial indicators and other semiprecision and precision measuring tools
- Understanding properties of materials, torque, and gearing
- Understanding the relationship of time, temperature, and pressure to success in the molding process
- Testing shear and tensile strength of bonded structures
- Understanding OSHA legislation and accident prevention practices

History–Social Science

- Understanding production systems, manufacturing companies, and how manufacturing technology has changed
- Understanding the labor movement and developing resources to trace histories of local manufacturing companies
- Understanding the sources and processing of raw material
- Tracing the development of the polymer industries
- Tracing the evolution of hand tools and mechanical devices
- Investigating the early use of casting and its use since the beginning of civilization
- Exploring automation and its impact on the social and economic structure of world societies
- Understanding the International Bureau of Weights and Measures and the United States Bureau of Standards
- Tracing the history of the Society of Manufacturing Engineers (SME) and the American Iron and Steel Institute (AISI) and their contribution to the manufacturing industries
- Tracing the discovery of iron and steel and the development of the steel industry
- Tracing the development of high technology processes and their effects on machine tools and processes

Visual And Performing Arts

- Understanding principles of design, line, and shape, as well as function versus application
- Understanding surface texture, finish, and shape and the relationship between function and design

Power, Energy, and Transportation Technology

Never has the need been greater for competent automotive, small engine, motorcycle, and truck and diesel service technicians and managers. In the past decade, the number of cars, trucks, and buses on this nation's highways has increased nearly 30 percent—from 124 million in 1973 to over 170 million in 1985. This says nothing of the large increase in the use of lawn and garden equipment and motorcycles. During this same period, however, the number of technicians has remained relatively constant—about 1 million. In fact, the average number of vehicles per technician has increased from 140 per technician a decade ago to over 210 per technician today. The average age of the current technician is approximately 55 years. According to the Motor Vehicles Manufacturers' Association, by 1990 at least 200,000 new technicians will be needed.

Numbers alone do not tell the story. Equally significant is the fact that motor vehicles continue to grow more sophisticated. As vehicle manufacturers try to meet often conflicting demands for improved performance in fuel economy, safety, and emissions and the shifting market, they are necessarily obliged to rely on more sophisticated technology.

On-board computers, electronic fuel injectors, turbochargers, diesel engines, rotary engines, front wheel drives, digital electronics, and exotic materials are everyday facts of life in vehicles today. These systems are here now and will become widely used in the years ahead.

Consumer expectations are at an all-time high. People legitimately expect their vehicles to function properly at all times. Considering the numbers and complexity of the various motor vehicles on the road today, it is unreasonable to expect the nation's service technician work force to handle these new demands without an appropriate education. They must be properly prepared to enter the field and must also receive adequate in-service training in the course of their careers

Teachers may remember when a course in auto mechanics was just that: mechanical. At that time, the car or truck was a mechanical vehicle with a simple electrical system for ignition, starting, lights, and gauges. A relatively simple set of hand tools enabled almost anyone to perform nearly any type of service.

Those days are gone forever. In a matter of decades the automobile has become a complex network of mechanical, electrical, electronic, and hydraulic systems and subsystems. Systems such as air conditioning, electronic ignition, electronic fuel injection, emissions controls, and intercommunicating on-board computers require manufacturers today to apply electronics, chemistry, and physics principles to a highly sophisticated degree. The vehicle service specialist is a technician in every sense of the word

No one technician should be expected to possess all the knowledge and skills needed to service today's wide variety of vehicle systems. An increasing number of technicians will specialize either by car line or by service area. The fully competent, general technician will mainly be used as a diagnostician who locates and identifies trouble and then refers service work to the appropriate specialist.

Industrial and technology education must adjust to this situation by providing greater in-depth training in individual automotive service specialties. An industry-education cooperative system should be planned so as to broadly train selected students to become diagnosticians and automotive educators

The need for an extensive automotive education program is inevitable. Automotive programs must maintain and teach according to nationally recognized standards as set forth by such organizations as the National Automotive Technicians Education Foundation or the Motor Vehicles Manufacturers' Association. Students leaving automotive programs must be certified by the national Institute for Automotive Service Excellence (IASE) within two years of entering the automotive trade.

Power, energy, and transportation technology programs enhance academic skills. A cooperative effort between school administrators, counselors, and teachers will assure that students gain the in-school preparation they need to be successful in a technological world.

Contents

11. Lubrication
12. Cooling Systems
13. Basic Engine Repair
14. Equipment Maintenance
15. Career Guidance
16. Gender Equity
17. Leadership
18. Safety

Motorcycle Repair

1. Safety
2. Tools and Equipment
3. Metrics and Precision Measurement
4. Motorcycle Engine
5. Motorcycle Power Trains
6. Motorcycle Fuel Systems
7. Motorcycle Electronics
8. Motorcycle Brakes
9. Motorcycle Frames, Wheels, Tires, and Suspension
10. Career Guidance
11. Gender Equity
12. Leadership

Automotive

1. Safety
2. Shop Practice
3. Job Opportunities
4. Consumer Information
5. Steering and Suspension
6. Brakes
7. Tires and Wheels
8. Engines
9. Fuel Systems
10. Electrical Systems
11. Emission Controls
12. Preventive Maintenance
13. Drivetrain
14. Auto Air-Conditioning
15. Automotive Tune-up
16. Career Guidance
17. Gender Equity
18. Leadership

Truck and Diesel

1. Orientation and Safety
2. Principles of Two-Stroke and Four-Stroke Diesel Engines
3. Engine Disassembly, Inspection, and Repair
4. Engine Assembly
5. Electrical Principles and Ohm's Law
6. Magnetism
7. Generators

8. Electrical Measurement Devices
9. Engine Electrical Systems
10. Cab and Chassis Electrical Systems
11. Hydraulics
12. Hydraulic Brakes
13. Air Brakes
14. Wheels and Tires
15. Steering
16. Suspensions
17. Fuel System
18. Normal Fuel System Servicing
19. Drivetrain
20. Transmissions
21. Clutch
22. Driveline and Carrier Assembly
23. Air-Conditioning
24. Airflow Systems
25. Positive Displacement Blower System
26. Turbochargers
27. Exhaust Systems
28. Tune-up
29. Manometers—Mercury and Water
30. Failure Analysis—Engine
31. Failure Analysis—Clutch and Transmission
32. Failure Analysis—Driveline and Differential
33. Failure Analysis—Brakes
34. Failure Analysis—Steering
35. Failure Analysis—Electrical
36. Business Practices
37. Career Guidance
38. Gender Equity
39. Leadership

Certification Program: Engine Repair

1. Engine Design/Systems
2. Engine Accessory Systems
3. Engine Problem Diagnosis/Troubleshooting
4. Engine Cleaning
5. Engine Measuring Techniques
6. Engine Assembly Techniques/Procedures
7. Engine Starting/Break-In Procedures

Certification Program: Engine Performance

1. General Engine Diagnosis
2. Ignition System Diagnosis and Repair
3. Spark Timing Controls
4. Fuel Systems—Carburetor
5. Fuel Systems—Injection
6. Idle Speed Controls
7. Fuel Vapor Controls
8. Inlet Air Temperature Controls

9. Intake Manifold Heat Controls
10. Positive Crankcase Ventilation
11. Exhaust System
12. Exhaust Gas Recirculation
13. Exhaust Gas Treatment
14. Engine Related Systems
15. Diesel Engine Fuel Delivery and Glow Plug Systems

Certification Program: Manual Drivetrain and Axles

1. Clutch Assembly
2. Manual Transmissions
3. Drivetrain and Axle Servicing
4. Differential and Axle Assemblies

Certification Program: Automatic Transmissions/Transaxles

1. Basic Gear Systems
2. Hydraulic and Friction Elements
3. Transmission/Transaxle Service and Repair

Certification Program: Brakes

1. Fundamentals
2. Hydraulics
3. System Service
4. Power Brakes
5. Brake Problems and Diagnosis
6. Brake Service Standards

Certification Program: Suspension and Steering

1. Suspension
2. Springs
3. Control Arms
4. Shock Absorbers
5. Joints
6. Steering Systems
7. Tires, Wheels, and Bearings
8. Inspections
9. Alignment
10. Diagnostic Charts/Glossary

Certification Program: Electricity and Electronics

1. Electricity Fundamentals
2. Electrical Components
3. Electrical Schematics and Diagnostics
4. Conductors and Wire Repair Techniques
5. Electronics Fundamentals
6. Electronic Components
7. Microprocessors
8. Batteries
9. Charging System

10. Starting System
11. Ignition System
12. Electronic Fuel Systems

Certification Program: Automotive Heating and Air-Conditioning

1. Fundamentals of Automotive Heating and Air-Conditioning
2. Automotive Cooling System Service
3. Basic Automotive Air-Conditioning System
4. System Components
5. Air-Conditioning System Service
6. Vacuum Control System
7. Electrical Control System
8. Special Tool and Safety Requirements for Air-Conditioning
9. Air-Conditioning System Testing and Diagnosis
10. Air-Conditioning Component Repair and Replacement

Certification Program: Collision Repair

1. Orientation and Safety
2. Measuring Systems and Mathematics
3. Hand Tools
4. Power Tools
5. Welding
6. Metallurgy
7. Sheet Metal Correction and Repair
8. Plastic Filler—Structural Plastics
9. Body Construction
10. Sheet Metal Alignment
11. Steering and Suspension
12. Special Operations
13. Mechanical and Electrical Repair
14. Career Preparation and Planning
15. Career Guidance
16. Gender Equity
17. Leadership

Certification Program: Auto Refinishing

1. Course Orientation/Shop Safety
2. Paint and Spray Guns and Paint Cups
3. Spraying Techniques
4. Spray Painting Equipment and Facilities
5. Surface Preparation
6. Automotive Refinishing Solvents
7. Undercoat Materials and Application
8. Automotive Color Preparation and Application
9. Panel and Sectional Panel Repair
10. Spot Repair Techniques
11. Color Matching Fundamentals and Techniques
12. Paint Conditions and Remedies
13. Painting Flexible Plastic Parts and Vinyl Tops
14. Rust Repairs and Prevention

15. Care of the Car and Paint Finish
16. Job Preparation
17. Measuring Systems and Mathematics
18. Career Guidance
19. Gender Equity
20. Leadership

1. Early Forms of Power	A technological progression from muscle power to the development of simple machines has led to the forms of power available today. *Standa : The student will understand the application of pulleys and levers and the concept of mechanical advantage.*
2. Water Power	A knowledge of hydraulic principles is elemental to the study of water power technology and systems. Understanding the history of water power is fundamental to the study of current and developing power technologies. *Standard The student will know and understand the principles of hydraulic power. The student will build and experiment with a simple water turbine.*
3. Air Power	Air-powered vehicles and tools provide significant examples of applied power and energy concepts. *Standard The student will understand how air may be used as a power source.*
4. Steam Power	Steam power was fundamental to the industrial revolution and to the development of modern electrical power generation. *Standara The student will understand the principles of steam power. The student will build and experiment with a steam turbine.*
5. Electrical Power	Electrical power, and its modes of generation, distribution, and utilization are of basic importance in modern technology. *Standard The student will understand simple principles of electricity.*
6. Internal Combustion Power	The internal combustion engine is widely known and accepted as a source of power in all areas of modern technology . *Standard The student will analyze and evaluate materials, tools, and products related to internal combustion power, including, but not limited to, their operation, manufacture, and use.*
7. Continuous Combustion Power	Continuous combustion power plays a prominent role in transportation, communication, and defense, in both developed nations and Third World countries. *Standard The student will understand the principles and applications of continuous combustion power and its effect on transportation and power generation.*

8. The Mechanic's Tools and Materials	Tools and measuring devices are fundamental and essential to all technological developments. Standard *The student will be able to choose a correct tool for an application, use it in an acceptable manner, and demonstrate its proper maintenance. The student will also be able to correctly interpret the readings taken from applicable measuring instruments and to analyze and evaluate tools for quality.*
9. Maintaining and Troubleshooting Small Gasoline Engines	The widespread use of small gasoline engines makes training in small gasoline engine principles necessary. Standard *The student will analyze and evaluate operation and maintenance problems related to small air-cooled gasoline engines.*
10. Transmitting Power	Mechanical and fluid power transmission is an essential technology widely used in industry. Standard *Students will understand power conversion, transmission, and utilization. Student understanding will include the operation, manufacture, service, and use of both mechanical and fluid power transmitting devices.*
11. Nuclear Power	The atom is the basis of all material known to man, and during the past century scientists have become increasingly aware of its energy potential. Nuclear power is a relatively recent technology. Standard *The student will be able to describe the basic operation of a nuclear reactor and explain how atomic energy can be converted to perform useful work.*
12. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering. Standard *Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.*
13. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today.

13. Gender Equity *(Continued)*	*Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
14. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society. *Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*
15. Safety	All students will be aware of the sources of potential hazards, safety rules and regulations, and effective ways of handling accidents as they occur. *Standard The student will have a thorough knowledge of the skills and attitudes necessary for the safe use of tools, machines, materials, and processes and will demonstrate this understanding at all times.*

1. Introduction	Appropriate laboratory procedures and safety considerations are fundamental to the productive industrial environment. *Standard The student will demonstrate knowledge of laboratory systems, safety, tool use, and career opportunities consistent with industry requirements.*
2. The Physical Science of Engines and Power Trains	A basic understanding of physical science principles related to small engines and power trains is essential to troubleshooting, repair, and operation procedures. *Standard The student will understand physical science concepts related to small engine design and operation, including energy forms, static inertia, dynamic inertia, force, torque, horsepower, power vacuum, and atmospheric pressure.*
3. Engine Operation	A basic understanding of two-cycle and four-cycle operation is fundamental to the proper diagnosis and repair of small-engine malfunctions. *Standard The student will have a basic knowledge and understanding of two-cycle and four-cycle engine operating principles.*
4. Cylinder Reconditioning	Understanding the process of cylinder reconditioning is necessary to successfully repair or rebuild the small engine. *Standard The student will understand cylinder reconditioning processes and techniques.*
5. Pistons and Piston Rings	Pistons and piston rings among the most common repair items in small engines. An understanding of piston and ring design, operation, inspection, and repair is necessary to successfully repair small engines. *Standard The student will demonstrate knowledge of piston and piston-ring construction, design, operation, troubleshooting, repair, and replacement consistent with industry standards.*
6. Connecting Rods and Crankshafts	Disassembly, repair, and reassembly of most small engines requires a knowledge of connecting-rod and crankshaft design, operation, inspection, and repair. *Standard The student will demonstrate knowledge of connecting-rod and crankshaft construction, design, inspection, repair, and replacement consistent with industry standards.*
7. Bearings and Seals	Bearing and seal removal, inspection, measurement, and installation knowledge and skills are fundamental to the repair of small engines.

7. Bearings and Seals (Continued)	*Standard The student will demonstrate knowledge of bearing and seal removal, inspection, measurement, and installation consistent with industry skill-level requirements.*
8. Valves, Seats, Guides, and Springs	The successful repair of the small engine requires an understanding of valves, seats, guides, and springs. *Standard The student will troubleshoot, repair, and replace valves, seats, valve guides, and springs consistent with industry skill-level requirements*
9. Fuel Systems and Carburetion Theory	Lawn and garden equipment, used seasonally, commonly exhibit fuel system malfunctions caused by improper storage. An understanding of fuel and carburetion systems is essential to the correction of related problems. *Standard The student will demonstrate knowledge of fuel types, two-cycle fuel mixtures, fuel pumps and filters, the physical science of fuel systems, diaphragm and float-type carburetion theory, troubleshooting and repair, air cleaner servicing, and governor repair and adjustments, consistent with accepted industry standards.*
10. Ignition Systems	Understanding the ignition system of a small engine is necessary to maintaining optimal engine performance. *Standard The student will demonstrate knowledge of the physical science of electricity, principles of magneto ignitions, principles of battery ignitions, and principles of spark plugs in a manner consistent with industry standards.*
11. Lubrication	Proper engine lubrication is essential to adequate engine service life. Understanding engine lubrication is necessary for proper engine servicing, maintenance, and operation. *Standard The student will demonstrate knowledge of friction, viscosity, lubrication types and specifications, and two-cycle and four-cycle lubrication systems in a manner consistent with industry standards.*
12. Cooling Systems	A cooling system is required in small engines and must be serviced regularly. An understanding of cooling systems is essential for proper engine operation and maintenance. *Standard The student will demonstrate knowledge of heat transfer, air cooling, and water cooling fundamentals in a manner consistent with industry standards.*

13. Basic Engine Repair	Integrating specific knowledge and skills learned in small engine repair into an overall small engine repair and maintenance perspective is imperative for applying skills in commercial environments. Standard *The student will apply knowledge of engine diagnosis, tune-up, carburetion repair, ignition repair, major engine repair, and drive system repair.*
14. Equipment Maintenance	Routine maintenance is fundamental to the longevity and proper operation of lawn and garden equipment. Standard *The student will demonstrate entry-level skills in oil changing, lube servicing, filter service, blade and hub servicing, and chain servicing.*
15. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering. Standard *Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.*
16. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. Standard *All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
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18. Safety

All students will be aware of the sources of potential hazards, safety rules and regulations, and effective ways of handling accidents as they occur.

Standard ***The student will have a thorough knowledge of the skills and attitudes necessary for the safe use of tools, machines, materials, and processes and will demonstrate this understanding at all times.***

265

1. Safety	Safety is an absolute requirement of any shop environment. Appropriate laboratory procedures and safety considerations are fundamental to the productive industrial environment. *Standard The student will demonstrate safe personal skills and the safe operation of equipment to avoid injury and financial loss.*
2. Tools and Equipment	The ability to correctly select and use tools and equipment in motorcycle repair distinguishes the professional from the novice. The appropriate care and use of tools and equipment is essential to meeting industry standards. *Standard The student will identify and select the proper tool for a specific application. The student will correctly use tools and equipment to perform a job to manufacturer specifications.*
3. Metrics and Precision Measurement	Ninety-five percent of motorcycles sold in America today are manufactured according to the metric system of measurement. All motorcycles require precision measurement because of their exacting mechanical tolerances. It is necessary for the technician to fully understand the metric system and be able to use precision metric measuring instruments. *Standard The student will display an understanding of the metric system and demonstrate its use in conjunction with performing specific measurements with the precision measuring instruments used in the motorcycle industry.*
4. Motorcycle Engine	The engine is the heart of any motorcycle and is the main focus of maintenance and repair. A theoretical and pragmatic understanding of motorcycle engine maintenance is essential in meeting industry standards. *Standard The student will comprehend engine theory and operation and will be able to apply this knowledge to the actual manipulation of parts and components in the performance of repairs to factory specifications.*
5. Motorcycle Power Trains	The power train is an essential system of the motorcycle necessary to transmit power from the engine to the rear wheel in a useful manner. It consists of several separate components, each dependent on the other for smooth transfer of power. Understanding the operation of each component in the motorcycle power train is necessary to proper diagnosis and performance maintenance. *Standard The student will understand the operation of each component of the power train and be able to perform diagnosis and repair functions to meet industry standards.*

6. Motorcycle Fuel Systems	The metering of fuel to meet the varied demands of the motorcycle engine is essential to its operation. The modern-day motorcycle utilizes several sophisticated systems to achieve exceptional horsepower-to-weight ratios and spirited performance. A thorough understanding of this system is essential to performing the difficult diagnosis and adjustment procedures required. Many engine malfunctions are directly related to problems in the fuel system. Standard *The student will understand the basic theory and operation of the motorcycle fuel system and perform diagnostic and repair functions appropriate to industry standards.*
7. Motorcycle Electronics	The most rapid technological advances in the motorcycle industry occur in the area of electronics. State-of-the-art modern electronic systems control many of the essential and auxiliary functions of the motorcycle. Use of this technology has increased in recent years and industry trends indicate rapid advances in the future. Tomorrow's motorcycle mechanic must demonstrate an understanding of electronic-theory diagnostic technique in order to be successful. Standard *The student will understand basic electronic principles and the fundamental electronic systems found in today's motorcycle in order to successfully diagnose electronic malfunctions.*
8. Motorcycle Brakes	Brakes are an essential component of the motorcycle. An understanding of the physical principles and actual operation of motorcycle braking systems is essential for diagnosis and repair. Standard *The student will demonstrate knowledge of brake principles and operation, including state and federal regulations as they apply to brake repair. The student will perform maintenance and repair operations on brakes in a competent manner, meeting legal requirements.*
9. Motorcycle Frames, Wheels, Tires, and Suspension	Frames, wheels, tires, and suspension systems all work in harmony to maximize motorcycle capabilities. Each component must be in tune with the other in order to provide optimum performance. Standard *The student will learn the operation, maintenance, and repair of motorcycle frames, wheels, tires, and suspension systems. The student will become familiar with the advantages of specific systems and components and be able to make specific recommendations relating to them.*
10. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that

such a program should be an integral part of a school's total educational offering.

Standard ***Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.***

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Standard ***All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.***

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12. Leadership

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Standard ***Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the use of the democratic process.***

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1. Safety

The work environment of the automotive service industry is inherently dangerous. Working with and in proximity to sharp pointed tools and objects; flammable, explosive, toxic, and corrosive chemicals; and hand, electrical, and pneumatic portable power tools all contribute to this condition. Knowledge of the hazards that exist, combined with specialized work skills and procedures, will enable work to be performed safely and effectively in this potentially dangerous environment.

Standard *The student will have knowledge of the dangers that exist in the work environment and will demonstrate the skills and procedures necessary to operate safely.*

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2. Shop Practice

The informed use of appropriate resource and recording documents is fundamental to the productive industrial environment.

Standard *The student will write repair orders and use technical service manuals, applying standards of the State Bureau of Automotive Repair.*

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3. Job Opportunities

Because of the continued shortage of skilled technicians, students should understand the qualifications and expectations required in a variety of careers. A wide variety of jobs in the work force require people with knowledge and skills in mechanical and automotive areas.

Standard *The student will understand the skills, personal qualities, and educational requirements needed for employment in a variety of automotive occupations. The student will develop an awareness of occupational choices and will be encouraged to to participate in student youth organizations to learn leadership skills.*

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4. Consumer Information

In order to work effectively both with consumers and as consumers, automotive technicians must understand the legal responsibilities of shop owners and technicians.

Standard *The student will understand the detailed information required on work orders and appreciate the need for legality in such documents. The student will understand the purpose and role of the State Bureau of Automotive Repair, the Automobile Club of America, the Automobile Club of California and its Garage Approval Section, and official police garages and towing agencies. The student will know how and where to shop for quality parts and service and will understand the economy and ecology of the automotive dismantler.*

5. Steering and Suspension

Steering systems on cars today have efficient turning, improved lateral motion, and advanced steering capability with few maintenance problems.

Standard *The student will study steering components by developing diagnostic, disassembly, and parts replacement skills as well as component testing and measuring skills. The student will study, identify, and diagnose suspension and alignment parts and problems.*

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6. Brakes

A recognition of brake service needs and an understanding of brake functions are of foremost importance to safe vehicle operation.

Standard *The student will understand basic braking system components and part functions. The student will study the physical principles of braking system operation and employ safety precautions when performing brake repairs. The student will know fundamental brake service operations.*

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7. Tires and Wheels

Safe motoring depends on the vehicle's directional stability, lateral control, proper wheel balance, and traction.

Standard *The student will identify tire and wheel sizes. The student will install tires and wheels. The student will balance tires.*

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8. Engines

The internal combustion engine is the main motive force in the automobile. Knowledge of engine operating principles and servicing techniques enables the technician to make adjustments and repairs for continued and efficient engine operations.

Standard *The student will understand engine operating principles. The student will describe major parts of an engine and the function of those major parts. The student will explain the operation of a four-stroke engine. The student will repair or replace selected automotive engine parts.*

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9. Fuel Systems

A knowledge of fuel system performance and maintenance is necessary to ensure efficient, pollution-free, and economical engine operation.

Standard *The student will outline the operation of a fuel system and identify and adjust components of carbureted and fuel-injected systems.*

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10. Electrical Systems

Understanding electrical system fundamentals is necessary to training in automotive tuning and diagnostic work.

Standard *The student will understand basic principles of electricity and electronics. The student will use proper technical terms and*

10. Electrical Systems (*Continued*)

values when measuring electricity and will understand the basic types of electrical circuits. The student will understand the operation and design of the automotive battery and the major components of starting and charging systems, and will explain interrelated operations.

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11. Emission Controls

The need for control of emissions has emerged from efforts beginning in the late 1950s and early 1960s. Control systems today are a major aspect of manufacturing, marketing, maintenance, and resale of automobiles nationwide.

Standard The student will understand the need for emission controls as an environmental priority and understand the development, function, and maintenance of various control systems. The student will define automotive emission systems, listing three types of emission controls. The student will explain the principles of emission controls and identify major parts of emission control systems.

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12. Preventive Maintenance

Prevention of breakdowns and costly repairs is the consumer's primary concern with vehicle operation. A fundamental knowledge of maintenance procedures can ensure continued reliable operation of the automobile.

Standard The student will know how to check fluid levels, perform required lubrication, troubleshoot vehicle systems and perform associated maintenance, identify required lubricants and fluid properties, identify and adjust drive belts according to manufacturer specifications, perform tire maintenance, and perform battery maintenance.

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13. Drivetrain

Parts that generate or transmit power to the road wheels constitute the drivetrain. Studies of drivetrains provide information on systems under constant use with a substantial potential of failure at any point in the life of the vehicle. Repairs to clutches, transmissions, drive shafts, and differentials represent a substantial percentage of consumer needs.

Standard The student will understand clutch operation; basic clutch parts and different types of clutches; and the operation of manual transmissions, transfer cases, and their complements. The student will understand the function of overdrive units, the parts and functions of automatic transmissions, different types of automatic transmissions, and the function of each drivetrain component.

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14. Auto Air-Conditioning

Many manufactured automobiles come equipped with air-conditioning units, and others are fitted with aftermarket units. An understanding of the operation of these systems, from minor servicing to freon

14. Auto Air-Conditioning *(Continued)*

replacement and belt changes, is expected of the automotive service person.

Standard The student wil! identify basic parts of an air-conditioning system, explain principles of air-conditioning refrigeration, and distinguish among major system designs.

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15. Automotive Tune-up

All vehicles require periodic tune-ups to comply with emission laws and standards and for economical operation.

Standard The student will demonstrate the use of engine diagnostic equipment. The student will replace the ignition, fuel system, and emissions components. The student will make adjustments to the engine, ignition systems, fuel systems, and emissions devices in order to comply with smog laws.

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16. Career Guidance

A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering.

Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.

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17. Gender Equity

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Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.

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18. Leadership

All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership development shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society.

Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the use of the democratic process.

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1. Orientation and Safety	**Appropriate laboratory procedures and safety considerations are fundamental to the productive industrial environment.** *Standard The student will understand the safe use and care of tools and chemicals, the proper placement and storage of parts and components, and the correct protective clothing and safety gear for various situations.*
2. Principles of Two-Stroke and Four-Stroke Diesel Engines	Basic two-stroke and four-stroke diesel engine principles are fundamental to the understanding, operation, and successful maintenance and repair of diesel engines. *Standard The student will understand the design, operating principles, and component parts of the two-stroke and four-stroke diesel engines.*
3. Engine Disassembly, Inspection, and Repair	Engine disassembly and the analysis of components for reusability are fundamental to the success of the truck and diesel technician. *Standard The student will disassemble, inspect, and repair parts that are reusable in a manner consistent with accepted trade practices.*
4. Engine Assembly	Knowledge of proper truck and diesel engine assembly is fundamental to meeting industrial standards. *Standard The student will assemble a diesel engine in accordance with manufacturer instructions and specifications. The student will identify and order new diesel engine parts as required.*
5. Electrical Principles and Ohm's Law	Understanding the basic principles of electricity and Ohm's law is necessary in the successful diagnosis and repair of truck and diesel electronics systems. *Standard The student will understand basic principles of electricity and Ohm's law, basic schematic symbols, and wiring fundamentals.*
6. Magnetism	Understanding magnetism is basic to the operation of electrical devices used in trucks and diesel engines. A working knowledge of magnetism is necessary for efficient repair and operation of the truck and diesel engine. *Standard The student will know and understand the basics of magnetic systems and related truck and diesel engine components.*

7. Generators	Understanding electric current induction is fundamental to understanding truck and diesel generator operation and the effective diagnosis of charging system problems. *Standard The student will understand mechanical-to-electrical energy conversion as applied in AC and DC truck and diesel generators.*
8. Electrical Measurement Devices	The appropriate selection and use of electrical system measuring devices is fundamental to the proper evaluation of related truck and diesel systems. *Standard The student will properly identify and demonstrate the use of truck and diesel electrical system measuring devices.*
9. Engine Electrical Systems	A thorough knowledge of starting, charging, and accessory circuits is essential to the proper repair of truck and diesel engine electrical systems. *Standard The student will accurately diagnose a defective component in the engine electrical system through the use of modern testing equipment and deductive reasoning.*
10. Cab and Chassis Electrical Systems	A thorough knowledge of sensing instruments, gauges and switches, and methods by which they are connected is necessary for effective diagnosis repair, and replacement. *Standard The student will diagnose gauge, switch, instrument, and wiring defects in cab and chassis electrical systems, using modern testing equipment.*
11. Hydraulics	Truck and diesel technicians need a grasp of basic hydraulic theory to understand the operation of hydraulic devices and for effective analysis of system problems. *Standard The student will know and understand the basics of hydraulic theory and the procedures for diagnosing problems. The student will be skilled in the removal, disassembly, repair, replacement, and testing of hydraulic components in a manner consistent with accepted industry standards.*
12. Hydraulic Brakes	An understanding of hydraulic brake operation and design is basic to effective system diagnosis and repair by the truck and diesel technician. *Standard The student will identify and understand the design, operation, and component parts of the truck and diesel hydraulic*

12. Hydraulic Brakes *(Continued)*	*brake system. The student will describe the proper procedure for system diagnosis and the removal, disassembly, repair, replacement, and testing of hydraulic brake components in a manner consistent with accepted industry standards.*
13. Air Brakes	An understanding of air-brake operation and design is needed to properly analyze, diagnose, improve, and evaluate system and component operations. *Standard The student will identify and understand the design, operation, and component parts of the air-brake system. The student will diagnose air-brake system problems. The student will remove, disassemble, repair, replace, and test air-brake components in a manner consistent with accepted industry standards.*
14. Wheels and Tires	An understanding of the classification and function of wheels and tires is needed for correct diagnosis and repair of wheels and tires by the truck and diesel technician. *Standard The student will identify and understand the design, operation, and component parts of wheels and tires. The student will diagnose, remove, disassemble, repair, replace, and test wheels and tires. The student will understand the importance of proper safety measures taken in compliance with industry and OSHA standards.*
15. Steering	Understanding the design and function of the steering systems is needed for diagnosis and repair by the truck and diesel technician. *Standard The student will know and understand the design, operation, and component parts of truck and diesel steering systems. The student will understand power steering pumps and actuators, steering ends, columns, gears, and the Acherman linkage. The student will understand steering alignment and will be able to diagnose, remove, disassemble, repair, replace, and test all steering components in a manner consistent with accepted industry standards.*
16. Suspensions	Understanding the design and operation of the suspension system is fundamental to proper diagnosis and repair by the truck and diesel technician. *Standard The student will know and understand the design, operation, and component parts of truck and diesel suspension systems. The student will diagnose system problems. The student will remove, disassemble, repair, replace and test suspension components in a manner consistent with accepted industry standards.*

17. Fuel System	Understanding the design and function of the fuel system is fundamental to diagnosis and repair by the truck and diesel technician. *Standard The student will understand the design, operation, and component parts of the fuel system. The student will diagnose system problems. The student will perform normal servicing of the fuel system in a manner consistent with accepted industry standards.*
18. Normal Fuel System Servicing	A basic understanding of proper methods for servicing and adjusting the truck and diesel fuel system is fundamental to diagnosis and repair in normal servicing situations by the truck and diesel technician. *Standard The student will identify and understand the design, operation, and component parts of the fuel system. The student will diagnose fuel system problems and will remove, disassemble, repair, replace, and test fuel system components in a manner consistent with accepted industry standards.*
19. Drivetrain	Truck and diesel components generating or transmitting power to the road wheels constitute the drivetrain. Understanding the design and function of the drivetrain is fundamental to diagnosis and repair by the truck and diesel technician. *Standard The student will understand the design of and describe the component parts of the drivetrain, including clutch operation, transmissions, and transfer cases.*
20. Transmissions	A knowledge of the types, function, and operation of the truck transmission is needed for efficient diagnosis and repair by the truck and diesel technician. *Standard The student will know and understand the component parts and principles of transmission operation. The student will demonstrate diagnostic procedures and the removal, disassembly, repair, replacement, and testing of the transmission and its components in a manner consistent with accepted industry standards.*
21. Clutch	A knowledge of the various clutch types and skill in the operation, repair, and maintenance of the truck clutch in modern diesel vehicles is required of the truck and diesel technician. *Standard The student will identify the various types of truck clutches. The student will diagnose clutch malfunctions and remove, disassemble, repair, replace, and adjust clutch components in a manner consistent with accepted industry standards.*

22. Driveline and Carrier Assembly	Understanding the theory and operation of the driveline and carrier assembly is fundamental to the efficient diagnosis and repair of these systems by the truck and diesel technician. *Standard The student will know and understand the principles of drive shafts, their angularity alignment, and phasing; and the principles of differential units an ' the methods of correct assembly and adjustment, using special manufacturer's equipment in a manner consistent with accepted industry standards.*
23. Air-Conditioning	Understanding air-conditioning principles, component parts, and service procedures is necessary for the truck and diesel technician to properly diagnose and repair systems. *Standard The student will know and understand the component parts and principles of air-conditioning. The student will diagnose systems and remove and replace air-conditioning components in a manner consistent with accepted industry standards.*
24. Airflow Systems	Understanding airflow concepts and system operation is needed to properly diagnose and repair airflow systems in an effective manner, consistent with industry standards. *Standard The student will understand the component parts and principles of airflow systems. The student will diagnose, remove, and replace airflow components, consistent with accepted industry standards.*
25. Positive Displacement Blower System	The positive displacement blower is an integral part of the two-cycle engine and an optional component for the four-cycle engine. Understanding the theory and principles of blower operation allows for the efficient troubleshooting and repair of this system by the truck and diesel technician. *Standard The student will identify and understand the component parts and principles of the positive displacement blower. The student will diagnose, remove, rebuild, replace, and adjust component parts of the blower in a manner consistent with accepted industry standards.*
26. Turbochargers	The turbocharger is a volumetric enhancement unit. An understanding of its purpose and function is needed for the proper diagnosis and repair of this system by the truck and diesel technician. *Standard The student will demonstrate knowledge of the theory of operation, nomenclature of components, and measurement skills applicable to turbochargers. The student will demonstrate the ability to diagnose malfunctions and make repairs.*

27. Exhaust Systems	A well-designed, free-flowing exhaust system is vital to the operation of any engine. An understanding of design features, components, operating function, and repair of exhaust systems is important to the proper diagnosis and repair of these systems by the truck and diesel technician. *Standard The student will know the component parts and operational principles of the truck exhaust system. The student will diagnose, remove, and replace exhaust components in a manner consistent with accepted industry standards.*
28. Tune-up	A proper engine tune-up is essential if an engine is to operate at full potential. An understanding of the proper diagnostic procedures and use of test equipment is needed by the truck and diesel technician. *Standard The student will understand the importance of a properly tuned engine. The student will perform all necessary adjustments, demonstrate sequential steps taken in diagnosing tune-up problems, and remove and replace components in a manner consistent with accepted industry standards.*
29. Manometers—Mercury and Water	The manometer is an essential tool in the proper tune-up and adjustment of a diesel engine. An understanding of this tool is important to the truck and diesel technician. *Standard The student will understand the proper uses of both mercury and water manometers in the performance of the tune-up and adjustment of various types of diesel engines.*
30. Failure Analysis—Engine	The analysis of broken or worn engine parts, of a noise, and of visual incongruities is an important aspect in the training of a competent technician. An understanding of these skills is of great importance to the competent truck and diesel technician. *Standard The student will visually inspect and analyze the cause or failure of defective engine components in a manner consistent with accepted trade practices.*
31. Failure Analysis—Clutch and Transmission	Analysis of broken or worn clutch and transmission parts, noise, and visual incongruities is an important aspect in the training of a competent mechanic. An understanding of these aspects is of great importance to the truck and diesel technician. *Standard The student will be able to visually inspect and analyze the cause of failure of clutch and transmission components in a manner consistent with accepted industry standards.*

32. Failure Analysis—Driveline and Differential

Analysis of broken or worn driveline and differential parts, noise, and visual incongruities is an important aspect in the training of a competent truck and diesel technician.

Standard The student will be able to visually inspect and analyze the cause for failure of driveline and differential components in a manner consistent with accepted industry standards.

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33. Failure Analysis—Brakes

Analysis of broken or worn brake parts, noise, and visual incongruities is an important aspect in the training of a competent technician.

Standard The student will be able to visually inspect and analyze the cause of failure of defective brake components in a manner consistent with current industry standards.

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34. Failure Analysis—Steering

Analysis of broken or worn steering parts and of noise and visual incongruities is an important aspect in the training of a competent truck and diesel technician.

Standard The student will be able to inspect visually and analyze the cause of failure of steering components in a manner consistent with current industry standards.

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35. Failure Analysis—Electrical

Analysis of burned out, broken, or worn electrical parts by odor or visual incongruities is an important aspect in the training of a competent truck and diesel technician.

Standard The student will be able to detect electrical problems by smell or visual inspection and analyze and correct defective electrical components in a manner consistent with current industry standards.

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36. Business Practices

Documentation, including parts orders, maintenance schedules, and work orders, must be properly completed. Such documents become legal records from which work is performed and invoices are generated.

Standard The student will understand the importance of proper documentation on the job, including parts used, time spent, and recommended future repairs. The student will be able to maintain records in a manner consistent with current industry standards.

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37. Career Guidance

A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering.

37. Career Guidance *(Continued)*	*Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.*
38. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. *Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
39. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society. *Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*

Certification Program: Engine Repair

Knowledge of engine operating principles, components/systems, and servicing techniques is required of the competent automotive technician.

Standard 1 The student will know and understand the principles and components of engine designs and systems and will be able to identify and understand the operation of all engine components through a comparison of all modern automotive engine designs and systems.

Standard 2 The student will know and understand the principles and components of the engine accessory systems and will be able to identify and understand the operation of each accessory system and how it relates to the operation of the engine.

Standard 3 The student will know and understand the principles and components of engine problem diagnosis and troubleshooting and will be able to identify and understand the proper diagnostic and troubleshooting sequence.

Standard 4 The student will know and understand proper practices of engine cleaning and will comprehend the reasons for proper engine cleaning.

Standard 5 The student will know and understand the principles and functions of engine service measuring devices and their proper use in the overall engine repair job.

Standard 6 The student will know and understand the principles and concepts of engine assembly techniques, including the proper procedures for engine prelubrication.

Standard 7 The student will know and understand the principles and functions of starting and break-in procedures and will comprehend the importance of proper engine break-in procedures.

Certification Program: Engine Performance

Knowledge of engine performance principles and related system servicing techniques enables the technician to understand, check, repair, and adjust each system.

Standard 1 The student will know and understand basic diagnostic tests and will demonstrate a knowledge of proper servicing procedures. The student will use test equipment and achieve results commensurate with industry standards and specifications.

Standard 2 The student will know and understand the principles and components of the ignition system. The student will demonstrate the diagnosis of ignition system problems, removal and replacement of components, adjustment of components, and testing of the system to ensure operation consistent with industry standards and specifications.

Standard 3 The student will know and understand the principles and components of the spark timing control system and will demonstrate *the diagnosis of system problems. The student will demonstrate the removal, replacement, and testing of system components in a manner consistent with accepted trade practices.*

Standard 4 The student will know and understand the principles and components of the carbureted fuel system. The student will demonstrate the diagnosis of carbureted fuel system problems and the removal, disassembly, repair, reassembly, replacement, adjustment, and final testing of system components in a manner consistent with accepted trade practices.

Standard 5 The student will know and understand the principles and components of fuel injection systems and will demonstrate the diagnosis of fuel system problems. The student will demonstrate removal, replacement, adjustment, and final testing of system components in a manner consistent with accepted trade practices.

Standard 6 The student will know and understand the principles and components of idle speed control systems. The student will demonstrate the diagnosis of idle speed control problems and the removal, replacement, and testing of system components in a manner consistent with accepted trade practices.

Standard 7 The student will know and understand the principles and components of the fuel vapor control system. The student will demonstrate the diagnosis of fuel vapor control problems, and the removal, repair, replacement, and testing of system components in a manner consistent with accepted trade practices.

Standard 8 The student will know and understand the principles and components of the inlet air temperature control system. The student will demonstrate the diagnosis of inlet air temperature control problems and the removal, repair, replacement, and testing of system components in a manner consistent with accepted trade practices.

Standard 9 The student will know and understand the principles and components of the intake manifold heat control system. The student will demonstrate the diagnosis of intake manifold heat control system problems and the removal, replacement, and testing of system components in a manner consistent with accepted trade practices.

Standard 10 The student will know and understand the principles and components of the positive crankcase ventilation system. The student will demonstrate the diagnosis of positive crankcase ventilation system problems, the removal and replacement of components, and testing of the system to ensure operation consistent with accepted trade practices.

Standard 11 The student will know and understand the principles and components of the exhaust system. The student will demonstrate the diagnosis of exhaust system problems, the removal and replacement of components, and testing of the system to ensure operation and compliance with emissions control standards.

Standard 12 The student will know and understand the principles and components of the exhaust gas recirculation system. The student will demonstrate the diagnosis of exhaust gas recirculation system problems, the removal, repair, and replacement of components, and testing of the system to ensure operation and compliance with emissions control laws.

Standard 13 The student will know and understand the principles and components of exhaust gas treatment systems. The student will demonstrate the diagnosis of exhaust gas treatment system problems, the removal and replacement of components, and the testing of the system to ensure compliance with emissions control standards.

Standard 14 The student will know and understand the principles and components of engine-related systems. The student will demonstrate the ability to diagnose, repair, replace, and service engine system components in a manner commensurate with industry standards.

Standard 15 The student will know and understand the principles and components of the diesel engine fuel delivery and glow plug systems and will demonstrate the diagnosis of system problems. The student will demonstrate the removal, repair, replacement, adjustment, and testing of system components in a manner consistent with accepted trade practices.

Certification Program: Manual Drivetrain and Axles

Manual transmissions and transaxles are major components in today's automobiles. Knowledge of components, adjustments, and measurements is essential for efficient diagnosis and repair.

Standard 1 The student will understand clutch assembly servicing and troubleshooting skills.

Standard 2 The student will understand manual transmission operation. The student will disassemble and reassemble a gearbox according to factory procedures. The student will demonstrate troubleshooting skills.

Standard 3 The student will demonstrate drivetrain and axle servicing and troubleshooting skills.

Standard 4 The student will demonstrate skills in the servicing and troubleshooting of several styles of differential and axle assemblies.

Certification Program: Automatic Transmissions/Transaxles

Automatic transmissions and transaxles are major systems in automobiles. Knowledge of gear system concepts, hydraulics, measurement, and repair procedures is essential for proper automatic transmission and transaxle maintenance and repair.

Standard 1 The student will demonstrate skill in selected gear system principles, including gear ratios, planetary gear operation, and power flow.

Standard 2 The student will understand selected hydraulic and friction element concepts.

Standard 3 The student will demonstrate the ability to check oil level and condition, drain and refill oil systems, replace filters, and make linkage and band adjustments. The student will understand component inspection when disassembling a transmission unit. The student will assemble according to factory procedure.

Certification Program: Brakes

In order to ensure the proper operation of braking systems, the technician must understand the fundamentals of brake system operation, measurement, analysis, and repair.

Standard 1 The student will diagnose, measure, and repair brake problems.

Standard 2 The student will understand wheel cylinder and master cylinder operation. The student will appreciate the need for brake control devices and proper brake fluid maintenance.

Standard 3 The student will repair brake systems of differing designs, both drum and disc, in conformance with industrial standards.

Standard 4 The student will diagnose power brake problems and will make repairs consistent with industrial standards.

Standard 5 The student will recognize, diagnose, and effectively repair identified brake system problems.

Standard 6 The student will understand why drums and rotors cannot be turned beyond legally established limits. The student will understand why both front drums or rotors must be turned to approximately the same size

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Certification Program: Suspension and Steering

Understanding vehicle suspension and steering systems is fundamental to gauging and diagnosing ride quality and directional control and in performing economical repairs.

Standard 1 The student will understand the components of various suspension systems, demonstrate the diagnosis of suspension and steering problems, and perform repairs in a manner consistent with accepted trade practices.

Standard 2 The student will understand automotive springs. The student will demonstrate the diagnosis of spring problems and perform repairs in a manner consistent with accepted trade practices.

Standard 3 The student will understand control arms and their components. The student will demonstrate the diagnosis of control arm problems and perform repairs in a manner consistent with accepted trade practices.

Standard 4 The student will understand shock absorbers. The student will demonstrate the diagnosis of shock absorber problems and perform repairs in a manner consistent with accepted trade practices.

Standard 5 The student will understand joints and their components. The student will demonstrate the diagnosis of joint problems and perform repairs in a manner consistent with accepted trade practices.

Standard 6 The student will understand various steering system components. The student will demonstrate the diagnosis of steering system problems and perform repairs in a manner consistent with accepted trade practices.

Standard 7 The student will understand tires, wheels, bearings, and related components. The student will demonstrate the diagnosis of related problems and perform repairs in a manner consistent with accepted trade practices.

Standard 8 The student will understand procedures in suspension and steering inspections. The student will demonstrate the diagnosis of suspension and steering problems and perform repairs in a manner consistent with accepted trade practices.

Standa d 9 The student will understand and demonstrate the correct alignment procedures in a manner consistent with accepted trade practices.

Standard 10 The student will correctly interpret diagnostic charts. The student will troubleshoot problems in a manner consistent with accepted trade practices. The student will also use correct terminology.

Certification Program:
Electricity a. Electronics

Sophisticated electronic technology is utilized throughout today's automobiles. Knowledge of basic electrical and electronic concepts is essential for efficient system diagnosis and repair.

Standard 1 The student will demonstrate skills requiring basic electrical principles. The student will understand electronic terms and functions, including Ohm's law, power law, and circuit theory. The student will understand the proper industrial use of electronic test equipment.

Standard 2 The student will differentiate among various electrical components. The student will understand proper testing techniques to apply to electrical components and assemblies.

Standard 3 The student will interpret and use electrical schematics in solving circuit malfunctions.

Standard 4 The student will demonstrate the s s necessary to perform wiring repairs that meet or exceed indust y standards.

Standard 5 The student will understand fundamental principles of semiconductors. The student will understand semiconductor terms, chemical structure, development processes, and theory of operation.

Standard 6 The student will understand sophisticated electronic components. The student will understand electronic functions, applications, and the proper testing techniques for electronic components and assemblies.

Standard 7 The student will understand the principles of microprocessor systems. The student will understand microprocessor terminology and diagnostic methods. The student will diagnose computer circuit malfunctions, using techniques consistent with industry standards.

Standard 8 The student will understand the construction, operation principles, and testing procedures related to automotive batteries.

Standard 9 The student will understand charging system principles and components. The student will use charging system knowledge to develop the skills to diagnose, remove, disassemble, repair, and test charging system components in accordance with industry-developed methods.

Standard 10 The student will understand starting system principles. The student will demonstrate skills required to diagnose, remove, disassemble, repair, and test starting system components, using methods approved by manufacturers.

Standard 11 The student will understand ignition system principles and components. The student will perform scheduled ignition system maintenance, replacement, adjustment, disassembly, and repair operations in accordance with industry standards.

Standard 12 The student will know and understand the principles and components of the modern electronic fuel system. The student will demonstrate the ability to diagnose malfunctions and to test, disassemble, adjust, and repair or replace fuel system components in accordance with manufacturers' specifications.

Certification Program: Automotive Heating and Air-Conditioning

All vehicles have heaters and 80 percent also have air-conditioning. Air-conditioning is one of the most popular automotive accessory selections. An understanding of air-conditioning and heating fundamentals is necessary to the development of a technician's diagnostic skills.

Standard 1 The student will understand the nature and behavior of heat. The student will know the rules governing the behavior of liquids and gases.

Standard 2 The student will inspect, diagnose, and repair conditions leading to or causing cooling system malfunction.

Standard 3 The student will describe basic heating and cooling system operation. The student will identify and state the purpose of each component necessary to a basic heating or cooling system.

Standard 4 The student will identify and state the purpose of system components manufactured for use in a variety of automotive air-conditioning applications.

Standard 5 The student will properly connect, operate, test, and service air-conditioning equipment. The student will conduct performance tests and identify normal system operating conditions. The student will evacuate and recharge an air-conditioning system.

Standard 6 The student will identify and test vacuum-operated components used to control heating and air-conditioning systems.

Standard 7 The student will identify and test electrically operated components used in air-conditioning control and sensing circuits.

Standard 8 The student will identify and use the special tools used in servicing a variety of air-conditioning systems. The student will safely perform service and repair of systems, using R-12 under pressure.

Standard 9 The student will determine necessary test procedures, gauge interpretations, and visual indications to isolate defective components.

Standard 10 The student will repair or replace components of the air-conditioning system in accordance with industry standards. The student will estimate repair times.

Certification Program: Collision Repair

Thirty-five million automobiles enter collision-repair shops each year for major and minor repairs. An understanding of modem practices of collision repair is essential to meet industry standards.

Standard 1 The student will pass a state-certified safety test with a 100 percent score. The student will understand the proper use of fire extinguishers and basic first aid. The student will know the basic job description of a collision technician and the high standards required in a class A body shop. The student will define the Vocational Industrial Clubs of America (VICA) and describe how participation in VICA can play a role in career development.

Standard 2 The student will understand the English and metric measurement systems. The student will understand the importance of applied mathematical skills on the job.

Standard 3 The student will know and identify hand tools. The student will demonstrate proper and safe tool selection for collision repair operations and the proper maintenance, care, and storage of hand tools.

Standard 4 The student will know the operating principles of power tools and their proper and safe application. The student will know *proper maintenance procedures for electrical, air driven, and hydraulic tools.*

Standard 5 The student will understand welding safety and demonstrate skill in the use of oxyacetylene and MIG welders. The student will know how to weld high-strength steel and will be familiar with the Interindustry Council on Automobile Repair (ICAR) welding certification program. The student will understand the plasma cutter.

Standard 6 The student will understand steel alloys and how they are produced. The student will know how the structure of the steel changes when panels are formed from flat, soft steel. The student will identify protective coatings put on steel in the factory, how they protect, and what safety precautions should be taken when working with coatings.

Standard 7 The student will know and understand the procedure for the removal and repair of various body dents. The student will demonstrate skill in the repair of damages both directly accessible and inaccessible, those in which the metal has been stretched, and those occurring on structural ridges. The student will understand the techniques for removal and replacement of welded panels, door skinning, and sectioning. The advanced student will demonstrate the finesse required in shrinking aluminum panels.

Standard 8 The student will know various types of plastic fillers, their proper application, and related proper tools to use. The student will identify different structural plastics and the proper repair techniques for each type.

Standard 9 The student will understand various auto body parts and types of construction. The student will understand the reasons for the drastic changes that have occurred in auto body engineering. The student will analyze damage patterns and correct the damage.

Standard 10 The student will use special equipment, such as jig systems, centering gauges, and laser systems, in the detection and correction of collision damage. The student will know what tools to use and the step-by-step procedure for removing, refitting, and aligning parts to original factory specifications.

Standard 11 The student will understand differing types of suspension systems and the basic function of each component. The student will understand various suspension adjustments and front-end alignment. The advanced student will perform a rear-end alignment.

Standard 12 The student will remove and refit interior trim, seats, carpeting, and panels. The advanced student will remove and refit windshield glass and side window glass and will demonstrate the proper use of rubber gaskets, seals, and glues.

Standard 13 The student will properly remove and install outer engine components, the engine itself, and related electrical components. The student will understand various pieces of electrical test equipment and troubleshoot common electrical malfunctions.

Standard 14 The student will prepare a personal data sheet outlining academic and vocational educational training and related work experience. The student will prepare an employment application, giving particular attention to neatness and accuracy. The student will understand appropriate personal appearance and grooming for employment interviews.

Standard 15 Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational preparation goals; and in expanding their individual options.

A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering.

Standard 16 All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.

A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today.

Standard 17 Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.

All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society.

Certification Program: Refinishing

Fundamentals and procedures used in automotive refinishing must be understood by the competent technician in order to participate economically in this field.

Standard 1 The student will understand the proper use of fire extinguishers and basic first aid. The student will understand the basic job description of a collision technician and the high standards required in a class A body shop.

Standard 2 The student will understand how to clean a spray gun properly after every paint operation. The student will understand the construction of suction-feed and pressure-feed guns and how the guns function. The student will disassemble and reassemble spray guns and will understand the purpose of various designs.

Standard 3 The student will understand the "why" behind every refinishing step, product, and procedure. The student will understand *why paint finishes fail and how paint application is controlled by the painter. The student will develop manual skills through many hours of practice.*

Standard 4 The student will know and understand the operation and components of spray painting equipment and facilities. The student will understand which respirators are approved and what type of eye protection to use. The student will understand the operation and maintenance of the transformer and compressor. The student will properly service spray booth filters and paint arresters.

Standard 5 The student will examine and analyze finished surfaces to determine the type and extent of surface preparation required. The student will learn what constitutes a proper or a poor surface condition.

Standard 6 The student will know and understand the proper solvent selection, mixture, and use, taking into account paint, surface type, and the ambient temperature and humidity.

Standard 7 The student will know and understand what undercoats are made of, how to select a proper undercoat, when to apply the undercoat, and how to verify that the substrate surface is properly prepared before application.

Standard 8 The student will know and understand the importance of proper surface preparation and of keeping tools and materials in good order. The student will understand the importance of following manufacturers' instructions. The student will use paint graphs and viscosity cups and will perform accurate liquid measurement when combining paints and solvents for refinish spraying. The student will learn to estimate refinishing costs.

Standard 9 The student will know and understand factory recommendations for painting panels on new and used cars. The student will prepare the surface; mask, thin, or reduce the color; and paint both sectional and complete panels. The student will use reverse masking in sectional painting and will be proficient in the color-coat and clear-coat paint systems.

Standard 10 The student will make successful spot painting repairs. The student will appreciate the value of continued patience and practice in developing spot painting skills.

Standard 11 The student will know and understand procedures and systems used in matching solid and metallic colors. The student will understand the value of having an eye examination to detect color blindness or other physical inability to determine proper color match.

Standard 12 The student will identify and correct common paint condition problems, such as the effects of ultraviolet rays, environmental problems, and chemical reactions.

Standard 13 The student will identify various types of interior and exterior plastics found in automobiles. The student will refinish *plastic materials, following accepted industry and manufacturer standards.*

Standard 14 The student will identify and remedy rust conditions. The student will learn procedures for preparing metal to retard oxidation.

Standard 15 The student will know and understand the harmful effects of ultraviolet rays, humidity, temperature extremes, industrial pollution, salt air, calcium chloride (road salt), and other chemicals on automobile finishes. The student will learn the proper application of various cleaning agents and protective materials on stainless steel, chrome-plated steel, anodized aluminum, vinyl, bright metal, and plastic combinations.

Standard 16 The student will prepare a personal data sheet outlining academic and vocational training and related work experience. The student will prepare employment applications with particular attention to neatness and accuracy. The student will appreciate the importance of appropriate personal appearance and grooming in preparing for an employment interview. The student will participate in practice interviews.

Standard 17 The student will know English system and metric units of measurement. The student will correctly and appropriately apply mathematical skills in auto refinishing operations.

Standard 18 Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.

A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering.

Standard 19 All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.

A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today.

Standard 20 Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.

All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society.

Power, energy, and transportation technology standards integrate academic core skills, including:

Language Arts

- Using vocabulary words in context
- Reading in context
- Developing listening skills
- Developing oral presentation skills
- Correctly interpreting industry standards
- Discussing technical information and writing reports incorporating appropriate technical terms

Mathematics

- Using concepts of geometry to understand and solve problems of engine operation
- Incorporating fractions, decimals, and English and metric systems of measurement when performing mathematical operations in the use of tools and equipment
- Computing parts costs, labor costs, total costs, profits, and loss
- Computing rotational angles with respect to timing and sequencing
- Using mathematical ratios with applications to drivetrain operations
- Comparing measured test results against manufacturer specifications to determine needed repairs
- Understanding geometrical steering concepts, including caster, camber, and toe-in on front ends
- Calculating horsepower, torque, shear force, and related drive-train characteristics

Science

- Studying and measuring mechanical power and force
- Understanding forces and their effects on matter
- Understanding that energy has been described as the ability to do work
- Understanding principles of leverage, torque, heat, electricity, magnetism, and pressure
- Understanding theories of volume, temperature, and pressure
- Learning the differences between heat and temperature
- Understanding the relationship of magnetic forces, electrical currents, and electromagnetic induction
- Understanding the physical-science concepts of static inertia, dynamic inertia, combustion, force, torque, atomization, volume, compression, horsepower, gravity, velocity, energy, power, vacuum, and atmospheric pressure
- Studying friction and lubricants
- Understanding and applying the Venturi principle
- Applying Boyle's law
- Knowing the principles of hydraulics and pneumatics
- Studying the nature of liquids and gases
- Understanding thermocouple operating principles

- Studying basic pump and valve principles
- Studying the principles of stress, tension, load, and springs
- Understanding the environmental requirements applied to exhaust systems

History–Social Science

- Studying major events in the development of power and energy
- Learning important chronological elements in the development of hydraulic power
- Studying the influence that tools, machines, power, and energy have had on economic and social growth and change in America
- Analyzing and evaluating the development of nuclear power and related social and environmental ramifications
- Exploring the historical development of unions and professional and trade associations
- Tracing the history of consumerism in the United States
- Studying technological advances in the automotive industry and their influences on society
- Understanding how schematic illustration has become a universal language, affecting intercontinental business relations

Visual and Performing Arts

- Studying the role that design and aesthetics play in the manufacture and marketing of products
- Using artistic skills and production techniques to create aesthetic automotive finishes and designs

Visual Communications Technology: Drafting

Regardless of their future choices, persons living in today's environment must be aware of the technical fields and their relationship to everyday life. The technical world employs drafting as its primary means of communication, and it depends on visual communications that affect virtually every walk of life.

In the past, a person could function adequately in the world of work with only one skill. Today's technology requires a worker to have multiple skills and to continually upgrade existing skills or acquire new skills in order to compete.

The model curriculum standards described in this section, "Visual Communication Technology: Drafting," cover the development of drafting skills and integrated skills from the very general or exploratory to the occupationally specific.

Contents

31. Fastening
32. Mechanical Drafting Orientation/Safety
33. Review/Competency Exam—Mechanical Drafting
34. Sheet Metal Development
35. Secondary Auxiliary Views
36. Descriptive Geometry
37. Assembly Drawings
38. Tolerancing
39. Geometric Tolerancing
40. Metric Dimensioning
41. Mechanical Drafting Careers
42. Inking
43. Welding Drawing
44. Graphic Communication System
45. Pictorial Assemblies
46. Working Drawings (Production Drawings)
47. Architecture—General Information/Safety
48. Architecture—An Overview
49. Architectural Drawing Procedures
50. Architectural Symbols
51. Design Concepts
52. Area Planning and Room Designs
53. Architectural Reference Data
54. Architectural Floor Plans
55. Schedules (Door, Window, Finish)
56. Architectural Electrical Plan
57. Construction Practices
58. Architectural Elevations
59. Architectural Site Plan
60. Foundation Plan
61. Building Details
62. Interior Details
63. Architectural Pictorial Drawing
64. Electronic Drafting—Orientation/Safety
65. Electronic Drafting—Media, Tools
66. Electronic Drafting—Lettering
67. Electronic Components
68. Electronic Symbols and Abbreviations
69. Electronic Drafting References and Standards
70. Block Diagrams
71. Schematic Diagrams
72. Connection/Wiring Diagrams
73. Cable or Interconnect Diagrams
74. Logic Diagrams
75. Printed Circuits
76. Printed Circuit Artwork
77. Chassis Drawing
78. Technical Illustration Orientation/Safety
79. Review (Technical Illustration)
80. Technical Illustration Careers
81. Introduction to and Use of Drafting Aids and Materials (Technical Illustration)

82. Freehand Technical Sketching
83. Types Of Pictorial Sketching
84. Layout and Construction Methods
85. Isometric Drawings—Technical Illustration
86. Career Guidance
87. Gender Equity
88. Leadership

1. Reprographics	Reprographics—the various processes used to reproduce drawings—constitutes an integral part of any drafting program. Understanding the fundamental principles of reprographics and how reprographics interfaces with drafting production in industry is essential for all drafters. *Standard The student will understand the various methods and materials used in reprographics. He or she will use this knowledge to reproduce original drawings by employing the materials and methods best suited to the original drawing and its final use.*
2. Piping Drafting—Introduction	Almost every conceivable fluid is handled in pipes during its production, processing, transportation, or utilization. Piping is also used extensively in hydraulics and pneumatics and is a structural element in columns and handrails. For these reasons drafters and engineers must have piping drafting skills. *Standard The student will understand pipe drafting and its varied uses and will demonstrate the ability to produce pipe drawings accurately.*
3. Structural Drafting—Introduction	Structural drafting is the basic language of the engineering profession, the construction industry, and structural fabricators. The training of structural drafters is vital to these professions. *Standard The student will understand the preparation of design and working drawings for buildings, bridges, tanks, towers, and other structures.*
4. Topography Drafting—Introduction	Topography drafting is the process of recording the features found on the earth's surface. Scientists, civil engineers, transportation systems, and the military all require accurate topographic maps. *Standard The student will understand and be able to demonstrate the skills necessary to draw accurate topographic maps.*
5. Computer Operations/Safety	Computer use in industry requires a knowledge and understanding of various operating systems and software. Employers are seeking applicants who have basic skills in problem solving, conceptualizing, and applying various computer systems and standard software packages to their particular industries. *Standard The student will demonstrate the application of two or more operational computer systems and their associated software. The student will be able to apply the functions and to troubleshoot common operational problems.*

6. Computer-Aided Drafting	Computer-aided drafting (CAD) is the application of computer technology to reduce the tedious and repetitive tasks associated with drafting, allowing the drafter to be more productive, creative, and responsive to the needs of business and industry. The drafting industry is rapidly converting to computer-aided drafting. Present-day technology requires the application of basic skills in conceptualizing, setting up data files, interacting with CAD software, and plotting orthographic and isometric drawings. *Standard The student will demonstrate a basic knowledge of computer-aided drafting (CAD) and the ability to use appropriate techniques and procedures for the care and use of hardware and software to produce a series of orthographic and isometric drawings.*
7. Basic Entity Creation	All completed drawings are developed from basic entities such as lines, curves, arcs, and rectangles. Crucial to the production of accurate detailed drawings is the ability to use a sequential pattern to develop precise basic entities that include Cartesian coordinates, polar coordinates, and absolute and relative input. Also crucial is the ability to calculate accurately to multiple decimal places. *Standard The student will understand the importance of developing precise basic entities and will demonstrate the ability to produce accurate drawings, using computer techniques and procedures.*
8. Entity Modification and Editing	Computer-aided drafting editing routines are required to manipulate individual entities and shapes to form complex drawings. *Standard The student will understand the function of editing commands and will demonstrate the ability to use edit commands to produce accurate drawings.*
9. Screen Control Commands	The computer graphics system draws in real coordinates. The monitor size limits the viewing area and necessitates the movement and manipulation of geometric shapes to develop accurate drawings. *Standard The student will demonstrate an understanding of zoom, pan, views, layers, color units, limits, windows, grids, snaps, and command functions. The student will demonstrate the ability to manipulate geometric entities on the monitor and to produce a drawing.*
10. Dimensioning Techniques (CAD)	A dimensioned drawing is required to produce a finished product. Computer-aided dimensioning techniques must follow specific standards and applications, and an understanding of these techniques is essential to the operator. *Standard The student will understand the proper use of American National Standards Institute (ANSI) standards and architectural*

10. Dimensioning Techniques (CAD) *(Continued)*	*standards and demonstrate the ability to represent dimensions properly.*
11. Symbol Libraries	Symbols of objects that are used repeatedly can be drawn once and then stored in separate cells in a computer library. The symbols can be recalled from the library data base and placed as desired without the need to redraw them. *Standard The student will understand the proper use and development of symbol libraries and will demonstrate the ability to use them in developing a drawing.*
12. Attributes	Attributes are attached to symbols to provide related technical information. The information can later be extracted through a data base to provide complete tabulations and technical data related to the drawing. *Standard The student will understand the development, use, and outcome of an attribute file and demonstrate the ability to provide a bill of materials.*
13. Three-Dimensional Drawings (CAD)	Three-dimensional drawings are produced in real coordinates and are used as an engineering design tool. Rotating the object allows viewing of all sides in true size and shape. *Standard The student will understand the use of X, Y, and Z axes in three-dimensional development and will demonstrate the ability to produce accurate drawings.*
14. Plotting	Plotting is required to produce hard copies of drawings generated on a CAD system. Drawings must be plotted to accepted industry scales and sheet sizes. *Standard The student will understand the proper technique of scaling and plotting to proper size and will be able to demonstrate that ability by plotting industry-quality drawings.*
15. Systems Drafting	Systems drafting involves the use of multiple overlay "pin registered" drafting, integration of CAD multiple overlays registering with hand drafting methods, photocopying and photo drafting, cut-and-paste work, and reprographics techniques and any other method that will speed the production and improve the clarity and readability of a final production drawing. *Standard The student will understand the methods and materials used in systems drafting and will use this knowledge to produce final production drawings.*

16. Drafting Orientation/ Safety	Orientation is the process of informing the students of course goals, objectives, requirements, room arrangement, equipment, and safety rules. It covers both cognitive and motor skill expectations. *Standard The student will understand the course direction and the need for assessing and evaluating his or her work and will understand the expectations for classroom control and safety.*
17. Career Orientation in Drafting	Understanding the career possibilities, the educational programs for attaining the careers, and the procedures in applying for a job are essential to the student. *Standard The student will understand the educational qualifications and levels on the drafting career ladder and will be able to demonstrate the ability to write a resume and complete a job application.*
18. Graphic Language	Understanding the history and the development of the drafting profession helps the student plan for future drafting and computer-aided drafting/computer-aided manufacturing (CAD/CAM) developments. *Standard The student will understand the history of drafting as a graphic language, will be able to identify early drafting tools and implements, and will understand why CAD/CAM is presently used.*
19. Care and Use of Tools and Equipment	Understanding the nomenclature, use, and care of the tools necessary to create the product is fundamental to the field of drafting. *Standard The student will understand the correct names and uses of drafting equipment, will be familiar with the media used in completing a drawing, and will understand the proper drafting techniques.*
20. Measurement	Measurement accuracy is essential to the field of drafting. A practical understanding of dimensions, units of measure, and measurement systems is necessary for proficiency in communications. *Standard The student will understand the importance of measuring systems and the measuring instruments involved in drafting and related fields. The student will develop the use of fractions, decimals, and metrics in measurement units.*
21. Lettering	Lettering is a fundamental requirement of the drafting industry. Understanding the application of lettering and having the ability to letter are basic requirements. *Standard The student will understand the importance of quality lettering and will demonstrate the ability to letter, using appropriate techniques and procedures.*

22. Geometry of Drafting	Understanding geometric construction is a basic requirement of drafters. *Standard The student will understand geometric construction and its mathematical background.*
23. Multiview Drafting (Orthographic)	Orthographic projection is the basic drafting visualization. *Standard The student will be able to identify and use correctly the alphabet of lines and will execute an object graphically, using the projection technique.*
24. Sketching	Freehand sketching is a fundamental skill used in developing concepts and in communicating ideas. *Standard The student will be able to produce well-proportioned and easily understood sketches.*
25. Beginning Reproduction of Drawings	Products of a drafting department are copies of drawings that can be distributed to those needing the information. *Standard The student will understand the need for clear drawings and be able to make reproductions.*
26. Dimensioning	Dimensions are required features on drawings, and the drafter is responsible for the correct application of dimensioning procedures. *Standard The student will understand basic dimensioning practices and will incorporate their correct use on drawings.*
27. Manufacturing Processes	Economical product design and production depend on the drafter's knowledge of terms, processes, and the specifications used in manufacturing. *Standard The student will understand the importance of manufacturing processes in the design of objects.*
28. Sectioning	The use of section views to reveal hidden detail is standard practice in the drafting industry. A thorough understanding of sectioning practices is essential for clear interpretation of drawings. *Standard The student will understand and incorporate section views and cutting planes to clarify hidden features of objects on drawings.*
29. Pictorial Drawing	Pictorial drawings are used throughout the drafting industry to help people visualize three-dimensional objects. They are also used in the visual presentation of products.

29. Pictorial Drawing *(Continued)*	*Standard The student will be able to draw objects accurately in pictorial format.*
30. Primary Auxiliary Views	Auxiliary views are a necessary adjunct to regular orthographic projection. They are used to show surfaces of an object that are not on a standard 90-degree viewing plane. *Standard The student will understand how auxiliary views are projected and will be able to demonstrate the ability to develop accurate auxiliary views of objects.*
31. Fastening	The use of fasteners and welded joints is an integral part of most manufacturing processes. The correct representation of these features is an essential part of the drafter's job. *Standard The student will understand the representation of common methods of fastening objects together and demonstrate these methods on completed drawings.*
32. Mechanical Drafting Orientation/Safety	Mechanical drafting orientation is the process of informing students of course goals, objectives, and requirements. *Standard The student will understand the basic course requirements, the method of student evaluation, the general objectives, class procedures, and course content, including safety information.*
33. Review/Competency Exam—Mechanical Drafting	A review and complete examination is vitally important for evaluating the student for placement in the proper drafting course. *Standard The student will understand the general competencies examination, will complete practice test problems, and will draw orthographic projections.*
34. Sheet Metal	Sheet metal development is the method of graphically developing various patterns and shapes for industrial processing. *Standard The student will understand the importance of accuracy in sheet metal development and will demonstrate the proper layout method for development drawings.*
35. Secondary Auxiliary Views	The drawing of a secondary auxiliary view is employed to determine the length of lines and shapes of surfaces not normal to a selected plane of projection. *Standard The student will understand the visual concept of how and when to place the auxiliary reference plane, will be able to visualize*

35. Secondary Auxiliary Views *(Continued)*	*the projection from the slanted surface, and will be able to simplify drawings through the use of auxiliary projection.*
36. Descriptive Geometry	Descriptive geometry is an important segment of the drafting industry. Understanding the application of descriptive geometry fundamentals to drafting problems is a valuable asset. *Standard The student will understand how to visualize, structure, form, design, and geometrically define objects. The student will understand the importance of orthographic projection.*
37. Assembly Drawings	Assembly drawings provide the means of viewing how parts fit together. *Standard The student will understand the types and purposes of assembly drawings.*
38. Tolerancing	Tolerance is the total amount of allowable variation in the specified size, form, or location of a feature or a part from that stated on the drawing. An understanding of how parts are made interchangeable by size control and the ability to apply tolerances, fits, and allowances are essential for interchangeable manufacturing. *Standard The student will understand tolerancing methods and demonstrate the ability to apply fits and allowances between mating parts.*
39. Geometric Tolerancing	Geometric dimensioning and tolerancing are means of specifying engineering design and drawing requirements with respect to actual function and relationship of part features. They ensure the most economical and effective production of parts. *Standard The student will understand and apply geometric and related symbols on drawings with respect to the parts function and design intent, in accordance with dimensioning and tolerancing standards.*
40. Metric Dimensioning	Most nations use the metric measuring system, and most of world production and trade is measured in metric units. Many multinational corporations based in the United States have overseas plants that use metric measurements, and there will be a growing demand for drafters trained in the SI (Système International d'Unités) metric system. *Standard The student will understand and apply metric dimensioning to drawings, using the current standards of dimensioning and tolerancing.*

41. Mechanical Drafting Careers	A variety of jobs are available in the drafting field. Many students are not aware of the opportunities in mechanical drafting, and the purpose of this unit is to identify various types of jobs associated with mechanical drawing. *Standard The student will develop an individual career plan, research and list the job level desired, fill out an employment application, prepare a resume, and compile a portfolio of drawings applicable to the selected field of employment.*
42. Inking	Microfilm storage and reproduction of drawings demand good, clear original drawings. This demand has stimulated the introduction of new and improved inking pens, materials, and methods. Governmental agencies and many large firms require that all drawings be inked. *Standard The student will demonstrate the ability to produce ink drawings that conform to current industrial standards.*
43. Welding Drawing	Welding is the process of heating and permanently fusing metals. Increased use of welding by industry has placed an increased demand on the drafter to use correct welding symbols. *Standard The student will demonstrate the ability to produce drawings showing the types, sizes, and locations of welds, using welding symbols in accordance with current industry standards.*
44. Graphic Communication System	The variety and sophistication of equipment, the volumes of drafting standards, the technical nature of materials, and the complexity of storage and reproduction of drawings requires an awareness of the various types of drafting performed in industry today. *Standard The student will read and prepare technical reports; understand and demonstrate the use of drafting standards; and gain insight in drawing-storage systems, systems drafting, computer-aided drafting, and configuration management.*
45. Pictorial Assemblies	Pictorial assemblies are used in all areas of engineering and science. The drawings form an integral part of the technical and service manuals for machine tools, automobiles, machines, appliances, and most manufactured products. They are used to show how parts fit together and the steps necessary to complete the product on an assembly line. *Standard The student will understand the structure, components, types, and applications of pictorial assemblies and demonstrate the ability to construct a pictorial assembly.*

46. Working Drawings (Production Drawings)

The manufacture and assembly of all personmade objects is accomplished using working drawings provided for each product.

Standard The student will understand the makeup of a working drawing and its place in the manufacturing process. The student will demonstrate the ability to complete the various types of working drawings, using appropriate line work, symbols, and standards.

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47. Architecture—General Information/Safety

It is necessary that the student be aware of the expected outcomes and competencies that will be acquired upon completion of this course.

Standard The student will understand the basic course requirements, the method of student evaluation, the general objectives, class procedures, and course content.

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48. Architecture—An Overview

An overview of the historical development of architectural styles and different drawing types is important to the prospective employee in architecture, as is an awareness of the various architectural career fields.

Standard The student will be able to differentiate between the various architectural career fields and their roles in the industry. The student will understand the historical development of architecture, including architectural styles and different drawing types.

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49. Architectural Drawing Procedures

Good line technique and lettering skills are essential to the completion of a well-defined drawing. Selection of sheet sizes and the ability to make correct architectural layouts are necessary for quality architectural drawings.

Standard The student will understand architectural drafting terminology and the correct names, care, and use of drafting tools. The student will demonstrate industry-standard line work, layout, and architectural styles of lettering.

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50. Architectural Symbols

Architectural plans are made of lines, symbols, and notes. Each symbol is interpreted by the reader of the plans to be a specific item or to represent a type of material to be used during construction. In order for the drafter to complete a set of architectural plans, a working knowledge of the proper use of symbols used in the architectural field is necessary.

Standard The student will demonstrate the proper use of symbols used within a set of architectural plans and gain experience in applying the symbols through exercises designed to develop these competencies.

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51. Design Concepts

The design of a building involves many steps, beginning with a definition of the needs of the occupants and ending with the finished set of plans. This process requires that the architect be knowledgeable in the following: construction techniques, building materials, orientation of the dwelling on the lot and in its surroundings, available utilities, building codes, and building costs.

Standard The student will know how to create a building design, how the orientation of the building on the lot affects the design, how the building codes affect the design, and what costs are associated with building.

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52. Area Planning and Room Designs

Area planning and room design require a knowledge of traffic patterns and space requirements for furniture applications, as well as the need to meet building and safety codes.

Standard The student will be able to identify and use symbols and will know the vocabulary associated with this unit. The student will be able to apply design principles to space planning and will be able to compare the minimum accepted standards allowed by the various codes to desirable design criteria. The student will use the proper dimensioning and lettering techniques associated with the living area.

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53. Architectural Reference Data

The information required to complete a working set of plans is more than any one person can be expected to memorize. An architectural drafter must have available many materials and product catalogs, manuals, code books, and textbooks to supplement the experience and information available from coworkers. The ability to use the many sources of information available in an architectural firm is essential.

Standard The student will use the various catalogs, manuals, and code books that are available in the classroom or library and will be able to locate material or information in them.

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54. Architectural Floor Plans

Good skills are necessary to present architectural information graphically in a way that is easily understood by the reader and that accomplishes the wishes of the owner. The floor plan is the basis for all other sheets in the set of architectural plans and contains much of the information used by building departments to verify compliance with the building codes.

Standard The student will apply critical thinking skills when drawing a floor plan. The student will define the problem and proceed in a logical manner to make judgments that will incorporate knowledge of the building codes, use of accepted drafting practices, application of space planning techniques, an understanding of traffic patterns, and knowledge of construction procedures.

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55. Schedules (Door, Window, Finish)	**Schedules list specific products to be used during the construction of the home. Without the schedules, the owner would not know what products the contractor will use in the home. Schedules are important, not only for the final product but also when the owner is seeking bids to begin construction.** *Standard The student will be able to draw a door, window and room finish schedule by locating product information to complete the schedule. The student will be able to identify the various types doors, windows, and finish treatments used in a home.*
56. Architectural Electrical Plan	The electrical plan in a set of building plans is an essential drawing to locate electrical fixtures and to provide other electrical information. *Standard The student will understand the necessity of an electrical plan and will demonstrate the ability to produce this plan.*
57. Construction Practices	Knowledge and understanding of various construction methods and techniques using wood, metal, concrete, and other building materials i. important to the architect. In addition, knowledge of the building codes, permits, and zoning requirements that regulate construction practices is necessary. *Standard The student will understand the various construction methods used in the building industry and will demonstrate this knowledge in the drawing of plans, details, and section views for a set of plans.*
58. Architectural Elevations	Elevation views of a building that is to be constructed are fundamental to describing and understanding the structure fully. *Standard The student will demonstrate the ability to construct elevation views of a building.*
59. Architectural Site Plan	The basics for the site plan are regulated by the zoning restrictions, bearings, curves, contours, and easements that determine location of the building on the site. *Standard The student will understand the importance of the site plan as part of the complete set of plans and will demonstrate the ability to construct this plan.*
60. Foundation Plan	The foundation plan involves contours, elevations, and mathematical calculations. Concrete, timber, and soil characteristics are considerations for the foundation. *Standard The student will be able to construct a foundation plan.*

61. Building Details	Building details provide the necessary information for constructing the foundation, walls, roofs, or any other building part that needs clarification. *Standard The student will construct a set of building details.*
62. Interior Details	Interior details provide the information required to build cabinets, fireplaces, and other interior parts of a building that may need definition. *Standard The student will construct a set of interior details.*
63. Architectural Pictorial Drawing	Pictorial drawings are used to illustrate how the completed building will look. *Standard The student will be able to construct a pictorial drawing.*
64. Electronic Drafting—Orientation/Safety	An overview of the types of drawings used in the field of electronic drafting and their application in industry provides students with an introduction to the general field of electronic drafting. *Standard The student will be able to identify the major types of electronic drawings and their uses in industry.*
65. Electronic Drafting—Media, Tools	Knowledge of the correct names, care, and use of drafting instruments and the media used in electronic drafting is important. *Standard The student will be able to correctly select the proper layout, pencil, drawing media, and inking equipment for a particular project.*
66. Electronic Drafting—Lettering	A knowledge of the correct type and style of lettering used in the electronic drafting industry is important to becoming a successful electronic drafter. *Standard The student will understand the proper use of transfer letters, lettering templates, and mechanical lettering devices.*
67. Electronic Components	Knowledge of the common electronic components used in the electronic drafting industry is important to the electronic drafter. *Standard The student will understand the proper use of common electronic components and their function in a given electronic circuit.*
68. Electronic Symbols and Abbreviations	Certain electronic symbols and abbreviations are used extensively in the electronic drafting industry, and knowledge of those symbols and abbreviations is important to persons entering the field.

68. Electronic Symbols and Abbreviations *(Continued)*

Standard The student will understand the proper use of common electronic symbols and abbreviations to identify electronic information.

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69. Electronic Drafting References and Standards

The military standards (MIL-STD) and ANSI and IPC standards and specifications are the standards for all electronic drawings.

Standard The student will understand the proper use and identification of the different standards by number and title.

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70. Block Diagrams

Students need to familiarize themselves with the purposes, types, and methods of drawing block diagrams.

Standard The student will identify the different types of block diagrams and understand their use.

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71. Schematic Diagrams

Schematic diagrams are the basic drawings in electronic drafting. They employ symbols for components and provide specific information about the value and type of each component. Schematic diagrams show the interconnections between components and other information necessary to an understanding of the symbols and circuits.

Standard The student will recognize symbols and demonstrate the ability to lay out electronic schematic diagrams from sketches.

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72. Connection/Wiring Diagrams

Connection/wire diagrams are the basic electronic assembly drawings and are used to show the connections between the various components and devices. There are several classifications of connection diagrams: pictorial, point-to-point, highway, and baseline.

Standard The student will recognize and understand the differences between the four types of connection diagrams and will demonstrate this knowledge in selected drawings.

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73. Cable or Interconnect Diagrams

Cable diagrams are used to show connections between various devices and systems. Very often the cable, or harness, may consist of ten or more wires, all color-coded for proper identification and connection.

Standard The student will understand the importance of interconnections between various devices and systems and will demonstrate this knowledge in selected drawings.

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74. Logic Diagrams

Logic diagrams are a fundamental requirement in understanding computer circuits. The functions within the circuits, gates, and registers switch from one state to another according to the input.

74. Logic Diagrams *(Continued)*	*Standard The student will understand the importance of logic symbols and will demonstrate an understanding that different shapes of symbols have specific functions in the design and reading of a diagram.*
75. Printed Circuits	Printed circuit boards are the standard in electronic construction. *Standard The student will identify single-sided, double-sided, and multilayered printed circuit (PC) boards. The student will demonstrate this knowledge in selected drawings.*
76. Printed Circuit Artwork	The artwork is the layout for printed circuit boards; therefore, accuracy and materials become extremely important. An understanding of the processes, procedures, and materials needed to produce PC boards affects the quality of the finished product. *Standard The student will understand the importance of PC techniques and will produce printed circuit artwork and related drawings.*
77. Chassis Drawing	Students must have the knowledge to lay out a chassis drawing for the housing of an electronic unit. *Standard The student will understand the importance of chassis design as it becomes an integral part of an electronic unit and will demonstrate this layout skill in selected drawings.*
78. Technical Illustration Orientation/Safety	Technical illustration, using airbrushing, pencil rendering, inking, and transparencies, provides a pictorial view of traditional engineering drawings. *Standard The student will demonstrate a knowledge of the correlation between pictorial drawings and engineering drawings.*
79. Review (Technical Illustration)	This unit will reinforce the basic requirements of technical illustration and will become the foundation for technical illustration skills. *Standard The student will demonstrate a knowledge of orthographic, oblique, isometric, and perspective drawings.*
80. Technical Illustration Orientation/Safety	The student should be aware of career possibilities as a technical illustrator, including the job market and pay scale that may be expected at an entry-level position. *Standard The student will benefit by becoming aware of career possibilities in this field, gaining a basic understanding and being able to make an intelligent choice in selecting a career.*

81. Introduction to and Use of Drafting Aids and Materials (Technical Illustration)	Of primary importance to the student illustrator is learning and mastering the basic tools and materials used in the field. Neatness and accuracy are important aspects of a good technical illustration. *Standard The student will demonstrate the knowledge and artistic skills that are a prerequisite for an illustrator.*
82. Freehand Technical Sketching	Sketching ideas and conveying concepts—as well as sketching a pictorial drawing from an orthographic drawing, and vice versa—are important aspects of drafting. *Standard The student will develop perception in drawing, sketching, and visualizing three-dimensional objects by making error-free sketches.*
83. Types of Pictorial Sketching	Pictorial drawings are the essence of technical illustration. They depict the three-dimensional objects as drawings that can be readily identified. They can also be used for selling products, for advertising, and for instructional aids. *Standard The student will be able to distinguish among sketching samples of various types of pictorial drawings, including axonometric, oblique, and perspective drawings.*
84. Layout and Construction Methods	Layout and construction are basic concerns for the drafter on an initial project. Special preparation must be made, particularly with work that involves inking and airbrushing. *Standard The student will appreciate the importance of an appropriate layout and the need for sequential construction methods. The student will demonstrate the skills needed to develop an overall plan for a quality product.*
85. Isometric Drawings (Technical Illustration)	The basic concept of pictorial drawings can best be taught by explaining and emphasizing the many applications of isometric drawings in most areas of technical art. *Standard The student will demonstrate the fundamentals of technical illustration and produce isometric drawings, demonstrating the ability to transfer concepts to other pictorial drawings.*
86. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering.

86. Career Guidance *(Continued)*	*Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.*
87. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. *Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
88. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of industrial and technology education courses and programs. Leadership development shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society. *Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*

The model curriculum standards in Communications Technology: Drafting integrate academic core skills, including:

Language Arts

- Using vocabulary words in context
- Reading in depth and interpreting building codes and topographical notations
- Reading and interpreting technical literature, manufacturers' specifications, and standards
- Interpreting and reproducing written notations properly
- Increasing listening skills through verbal instruction, demonstrations, and student interaction
- Reinforcing speaking skills through demonstrations and presentations
- Writing clear, concise notes on drawings, using standard abbreviations and correct spelling

Mathematics

- Reinforcing basic mathematical concepts, skills, and problem solving relating to fractions, percentages, scales, and proportional measurement
- Assessing numbers, measurement, geometry, and pattern problem solving
- Using mathematical concepts and measurement, solving trigonometric surveying problems
- Developing higher-order thinking skills in mathematics as applied to binary and hexadecimal concepts and American Standard Code for Information Interchange (ASCII) codes
- Developing intricate geometric shapes, using basic entities
- Developing drawings, using decimal, metric, and fractional unit scales
- Determining the strength of materials to calculate load-bearing weights

Science

- Understanding forces and their effects upon materials
- Defining, measuring, and calculating various characteristics of substances and materials
- Understanding solar and wind effects on a building site
- Understanding the geological and environmental effects created by urbanization
- Applying physical-science concepts, such as solar heating, insulation, thermal mass, and heat loss, to the design of a structure
- Understanding the physical properties of building materials and why they are used in different architectural styles
- Understanding the chemical composition of finish materials used in a house and the application of these materials
- Applying physics concepts involving problem-solving and using inference, balance, proportion, and shape definitions

- Applying the use and movement of wire frames, planes, and solids
- Understanding the process of bending, stress, breaking points, and flexibility of materials used in the manufacturing process

History–Social Science

- Understanding the important chronological events of an ever-changing technological society and its effect on design of equipment and buildings
- Tracing the history of structures and their relationship to civilizations and cultures
- Reviewing the history of measurement and surveying and how they helped develop and assist past cultures
- Tracing the important chronological elements of computer usage to combine the technical language of industry with computer-aided drafting
- Tracing the development of units of measurements and their applications in various cultures
- Understanding copyright laws, their origin, and implementation
- Studying the economic impact of various building materials and supplies and their effect on the final cost of construction
- Researching the economic value of land and its development
- Studying the economic impact of space planning on the consumer's budget

Visual and Performing Arts

- Learning, through reprographic techniques, how to create aesthetic, quality drawings; expanding and refining kinesthetic, aural, tactile, and visual sensibilities through artistic processes
- Learning that social, political, economic, and technological events and aesthetic judgments influence the development of structural design
- Designing and reproducing drawings that present information efficiently and effectively
- Understanding balanced, intricate geometric designs and proportional patterns, using line style, form, and value
- Developing artistic skills and creativity, using proportion and balance when editing geometric patterns and shapes
- Understanding that drafting is a visual art form that provides a means of nonverbal communication
- Understanding the design features of each historical style and its differences, with emphasis on the technological events that have influenced the development of artistic skills
- Determining the use of color when completing a finish schedule
- Developing artistic skills and artistic judgment; learning the interrelationships between architecture and nature
- Developing an appreciation of lettering styles and designs
- Using sketching techniques and design elements of balance and proportion
- Defining, measuring, and calculating the various physical characteristics of objects in a technical illustration

Visual Communications Technology: Graphics

The model curriculum standards in Visual Communications Technology: Graphics play a central role in enhancing academic core content and skills, expanding the student's employability and career awareness, and promoting his or her level of technical competence.

Visual Communications Technology: Graphics focuses on communications, photography, graphic arts, commercial art, commercial photography, and graphic communications. The student's acquisition of new knowledge, the development of awareness of individual interests and abilities, and the application and transfer of skills learned in other disciplines are fundamental concepts in this program.

Participation in Visual Communications Technology Standards: Graphics enables the student to become familiar with historical, current, and potential developments in industry and technology as well as the effects of such developments on consumers and other members of society. As a result, the student will be able to make informed career/occupational (educational) decisions based on the knowledge and skills acquired and in accordance with his or her personal interests and aptitudes.

Contents

27. Contact and Projection Printing
28. Finishing and Mounting
29. The Process Camera
30. Films, Papers, and Chemistry
31. Diffusion Transfer
32. Special Screen Effects
33. Paper Manufacturing
34. Paper Cutting, Handling, and Storage
35. Other Substrates
36. Ink
37. Offset Lithography
38. Offset Duplicators and Presses
39. Lithographic Plates
40. Stencil Printing
41. Gravure
42. Letterpress
43. Flexography
44. Ink Jet and Electronic (Laser) Printing
45. Electrophotographics
46. Binding Operations
47. Career Guidance
48. Gender Equity
49. Leadership

1. Printing History	Graphic communications had its beginning in the pictures created by early humans on cave walls and has developed into a complex industry that uses graphic communication satellites to communicate across thousands of miles. It is necessary to understand the history of graphic communications to fully appreciate its impact on the modern world. *Standard The student will know how the industry developed from the earliest forms of printing and will appreciate early developments of paper and ink.*
2. Career Opportunities	The printing and publishing industry represents approximately 3 percent of the gross national product with more than 50,000 establishments offering a wide variety of career possibilities. *Standard The student will make intelligent career decisions based on exposure to specific job requirements, on necessary training, and on an awareness of programs offered in higher education.*
3. Products and Processes	The printing industry is composed of more than 50,000 firms producing a wide variety of products. These products are primarily intended for person-to-person communication. Printing plays a key role in the generation of products by other industries, such as textiles, wallpaper, toothpaste tubes, and soft-drink cans. *Standard The student will identify goods produced in their entirety by the graphic arts industry as opposed to goods made by other industries assisted by the graphics industry. Students will have knowledge of various image-transferring processes.*
4. Health and Safety	Safety is an important part of all graphic art processes and is stressed throughout the industry. The use of chemicals and a wide variety of machines requires knowledge of safety fundamentals. *Standard The student will be aware of basic health and safety laws. The student will understand shop safety and will work to prevent accidents. The student will know the various classes of fires and how to use a fire extinguisher.*
5. Postal and Legal Restrictions	The production of security documents, including stocks and bonds, currency, stamps, material covered by copyright, and registered material, demands a knowledge of legal limitations. Postal regulations are also important since many printed products are distributed through the postal system. *Standard The student will understand postal regulations, copyrights, register marks, and trademarks and will be able to identify products that may be and may not be reproduced and mailed.*

6. Cost Awareness	The graphics industry is a competitive field. Productivity must be kept high and spoilage kept at a minimum to ensure maximum profit. There are variables to consider when estimating the cost of a job, and accuracy in this estimation is vital to the financial health of a company. *Standard The student will understand how to accurately estimate production costs of typical printing jobs.*
7. Measuring Systems	The point and the pica are two units of measure universally used in printing to communicate instructions to graphic designers and typesetters. *Standard The student will understand the printer's measuring system and will be able to apply it to compute all calculations of line and column measure.*
8. Allied Industries	The graphics technology industry functions to produce a printed product intended to transmit a message. Supplies and services necessary to produce the product are supported by an extensive number of allied or related industries, such as the film, papermaking, ink, and chemical industries. *Standard The student will identify various allied industries and the importance of their services to the printing industry.*
9. The Quick Print Shop	Copying and duplicating are also called reprography. For fewer than ten copies, the copier offers the fastest, most convenient and economical method of duplication. For larger jobs, high-speed copiers and duplicators are used. Reprography is used extensively by over 80,000 in-house printing departments and quick printing shops in the United States, making it a vital area in the graphics industry. *Standard The student will understand various reprography/quick copy techniques that led to the success of the quick print shop.*
10. New Technology	The future of the printing process is being shaped by the versatility and capabilities of the microcomputer and the microprocessor. Systems are being developed for making printing plates and cylinders directly from original copy, without the need for intermediate photography or film. Printing is entering a "filmless" era. Printing with ink jets and electronics is becoming commonplace. *Standard The student will know and practice with new technologies in the printing industry.*
11. Planning and Management	The printing industry is a planned management production system. Managers decide what equipment to buy and who will operate the

11. Planning and Management *(Continued)*	equipment. Good management is the key to a successful printing plant. *Standard The student will define the purpose and function of management in planning, organizing, and controlling.*
12. Estimating	The cost of each printing job must be calculated. Estimating skills ena 'he saleman to provide the customer with an accurate quote. *Standar. The student will understand economic variables, including material cost, labor cost overhead, general and administrative cost, contingency, and profit when estimating a total printing job cost.*
13. Production Scheduling	Scheduling involves planning the flow and sequence of processes for the production of an order. Schedule makers must consider processes, equipment, material availability, capacity, quantity, and outside materials and processes required. *Standard The student will understand production scheduling.*
14. Customer Service	Good customer relations are vital to the success of any company. The service representative in a printing industry conveys the image of the company to the public. The representative should be prompt, complete work accurately, and be sympathetic to customer needs. *Standard The student will appreciate the value of good customer relations and a positive company image.*
15. Generating Art	Image generation involves the production of visual elements necessary to production. Art technologies range from hand drawing or painting to computer-generated graphics and photographic images. *Standard The student will understand original, clip art, camera, computer, laser photography, and other methods of generating artwork.*
16. Mark-up and Copyfitting	The first practice in composing is to mark up or copyfit in a type-set format. Type spacing is performed by the layout artist, designer, or typesetter. *Standard The student will use the printer's measuring system. The student will understand how to perform copyfitting and mark up, using the pica-point system. The student will perform a character count, select typeface and size, and determine leading, line length, and copy position.*

17. Proofreading and Editing	**Proofreading is done before a..d after a manuscript is set in type to discover errors and to mark them for correction. Editing is the act of changing or correcting composition and may occur three times: prior to mark-up, during input (correcting input errors), and in the galley proof. The proof is sometimes sent to the customer for corrections and final approval.** *Standard The student will understand proofreading marks and will know the importance of correct spelling, punctuation, and grammar skills.*
18. Generating Type Art	**Image generation may be divided into two classifications: hot composition and cold composition. The five major functions necessary to image generation are inputting, storage, editing, computing, and generation (typesetting).** *Standard The student will understand various image-generation techniques, including dry transfer, strike on, photocomposition, laser and digital composition, line casting, foundry, and illustration. The student will understand the practical advantages of various image-generation techniques, such as direct input, off-line keyboard, video display terminal, front-end systems, laser output systems, and personal-computer–based publishing systems.*
19. Typography	Typefaces are grouped into classifications having unique design features. Recognizing these classifications is necessary before appropriate type can be selected for a particular need. *Standard The student will identify various classifications of type by distinguishing characteristics and character components.*
20. Types of Copy	Image-generation methods are traditionally matched to production processes. Selecting an appropriate image-generating method requires a thorough understanding of the graphics technology industry. *Standard The student will recognize various types of copy and select one or more associated process for generating copy.*
21. Art Services	Drawings or artwork add clarity and interest to the visual message. Clip art, or over-the-counter artwork, is a valuable tool in the graphics industry. *Standard The student will demonstrate the use of preprinted separations, headlines, artwork, borders, and other production aids.*
22. Design Principles	Design principles are logical, accepted, and identified fundamentals in graphics technology. A knowledge of the basic principles promotes the success of the design task.

22. Design Principles *(Continued)*

Standard The student will understand basic design principles, including balance, proportion, contrast, rhythm, unity, and color. The student will apply basic design principles in a graphic design.

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23. The Mechanical

The mechanical or pasteup is the organization of visual elements into a final form. The assembly of elements is based on design variables and the overall, comprehensive layout.

Standard The student will demonstrate how to assemble visual elements to make a pasteup. The student will understand the difference between line and continuous tone copy. The student will identify the correct tools for making mechanicals.

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24. Stripping and Imposition

Stripping is the positioning of film images for lithography, intaglio (gravure), and screen printing. Imposing refers to the positioning of relief images for multipage lockup in relief printing. Both concepts are fundamental in the graphics industry.

Standard The student will understand the importance and technique of stripping and imposing in graphic arts production. The student will understand career opportunities, working conditions, and training requirements for positions in stripping and imposition.

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25. General Photography

General photography is a creative method of visual communication frequently used in books, newspapers, magazines, catalogs, and advertisements. Photography influences many aspects of our lives, assisting us in making purchasing decisions and helping us to record our daily lives.

Standard The student will understand available camera types, film types, paper and developing methods, the correct use of light and lighting sources, and principles of composition and finishing. The student will make photographic prints in the darkroom.

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26. Film Processing and Quality Control

Photosensitive emulsive materials will produce latent images when exposed to light. Proper treatment of the film in a developer will make the latent images visible. Light is a key element in the reproduction of an image on light-sensitive materials. If the optimum amount of light enters the camera, the resulting photograph will have maximum detail.

Standard The student will exhibit an understanding of the film developing process. The student will understand chemical and quality-control techniques and will demonstrate this understanding through the successful processing of photographic film.

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27. Contact and Projection Printing

Many photographic procedures, such as reverses, spreads, and chokes, involve contacting a negative or positive to another piece of

27. Contact and Projection Printing *(Continued)*	film. Contacting is also used to reduce the number of flats needed to make the plate. Projection printing is nearly the same process, except the copy is usually enlarged or reduced. *Standard The student will understand contact and projection printing. The student will know how to make spreads, chokes, and reverses and will know how to enlarge and reduce.*
28. Finishing and Mounting	Once a negative has been printed, washed, and dried, various treatments may be used to change the appearance or enhance the quality of the finished print. Proper trimming of the borders of a finished print will often improve its appearance. If the print is to be displayed, it is essential that the technician understand appropriate mounting techniques. *Standard The student will understand photographic finishing (spotting) and mounting techniques.*
29. The Process Camera	Process cameras are used to produce images on film, diffusion transfers, or transparencies. These images may be enlarged or reduced. This process results in a film negative or positive used for plate making and other printing purposes. There are two types of process cameras: horizontal and vertical. Both types of cameras operate in essentially the same way, differing only in construction. *Standard The student will know how to operate the two types of process cameras to produce consistent, usable results.*
30. Films, Papers, and Chemistry	Underlying all photographic processes is the fact that light energy causes a chemical change in a light-sensitive emulsion. Photographic materials are classified by type of emulsion and vary in color sensitivity, contrast, and speed. *Standard The student will identify various types of photosensitive materials, describe their chemical makeup, and categorize them by color sensitivity, contrast, and speed. The student will demonstrate the safe handling and storage of films, papers, and chemicals.*
31. Diffusion Transfer	Diffusion transfer incorporates a two-part (negative and receiver sheet) photographic material. The negative material is exposed and a positive image is transferred onto the receiver during processing. This process can be used to make pasteup layouts for scanning and comprehensive layouts for customer approval or for presentations. *Standard The student will understand the diffusion transfer process. The student will be able to determine when the process should be used.*

32. Special Screen Effects

Special effects are used in the graphics industry to enhance or change the visual effect or appearance of an original tone copy. Effects include line, multicolor, tone posterization, duotones, and fake duotones. Various screen effects used include mezzotint, etch tone, dry brush, and straight line.

Standard The student will demonstrate a knowledge of photographic techniques used to produce special screen effects.

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33. Paper Manufacturing

Paper is made from cellulose fibers, using trees as a primary source of pulp fiber. There are four pulping processes: mechanical, chemical, semichemical, and thermomechanical. Over the past 50 years, per capita consumption of paper has tripled. The environmental impact on our society of the harvesting of trees and the consumption of this resource is due in part to the relationship of the papermaking industry to printing.

Standard The student will understand the importance of timber cellulose fibers in paper production. The student will explain the processes of pulping, bleaching, refining, forming, and finishing. The student will understand the impact of papermaking on natural resources.

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34. Paper Cutting, Handling, and Storage

Cutting of standard-sized papers requires a knowledge of papergrain direction, humidity resistance, and shelf life. Paper cutting is a fundamental process in the graphics industry.

Standard The student will understand the need for standard paper sizes, know how to determine the grain direction in paper, and know how to cut a standard sheet for printing so as to minimize waste.

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35. Other Substrates

The most widely used printing surface is paper. Alternative printing surfaces include wood, plastic, metal, acetate, and fabric. An awareness of alternative substrates is important, as they have a variety of applications in the printing industry.

Standard The student will identify substrate alternatives to paper and describe a printing process appropriate to each alternative described.

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36. Ink

Printing inks are colored coating materials applied to the surface of paper, plastic, metal, glass, and wood. Printing inks provide a visible image on books and magazines, identify food through packaging, and decorate fabrics.

Standard The student will understand ink chemistry. The student will identify various products on which ink can be applied.

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37. Offset Lithography

The most widely used printing process, lithography, uses the planographic method. In this method, image and nonimage areas are essentially on the same plane of a thin metal plate. When the printing plate is made, however, the printing image is rendered grease receptive and water repellent, while the nonimage areas are rendered water receptive and ink repellent. During printing, the image is transferred from the inked, greasy areas of the plate to a rubber blanket before transfer to the paper. This transfer method is called the offset principle. Letterpress and gravure can also incorporate this offset principle.

Standard The student will describe the offset lithography process. The student will identify various products printed by this process. The student will know the advantages as well as the limitations of offset lithography.

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38. Offset Duplicators and Presses

Offset duplicators and presses are available in a wide variety to meet every printing requirement. The fundamental fact that grease and water do not readily mix is the basic operating principle of all offset lithography duplicators. Offset duplicators and presses are used for 44 percent of products in the publishing and packaging areas and are found in practically every quick print and commercial shop in the country.

Standard The student will understand the operating principles of a variety of duplicators and presses. The student will know sheet and image size limitations and the number of impressions possible per hour on each press.

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39. Lithographic Plates

Lithography is based on the principle that grease and water do not mix. On a lithographic plate, the separation between the image and the nonimage areas is maintained chemically. The image areas must be ink receptive and the nonimage areas must be water receptive and refuse ink. There are three types of lithographic plates: surface, deep-etch, and bimetal.

Standard The student will understand the chemical principles that make lithography possible. The student will be familiar with the three types of lithographic plates, their chemistry, image quality, impression capabilities, and exposure requirements.

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40. Stencil Printing

Formerly known as silk-screen printing, stencil printing employs a porous screen mounted on a frame. A stencil is produced on the screen, either manually or photomechanically. Ink is forced through the screen in areas unprotected by the stencil to produce the image. Common types of stencil materials are paper, tusche and glue, hand-cut, and photographic film. Versatility is the principal advantage of screen printing.

40. Stencil Printing *(Continued)*	*Standard The student will explain the stencil printing process. The student will understand the advantages and disadvantages of stencil printing.*
41. Gravure	Gravure is a form of intaglio printing. Image areas consist of wells etched into a copper cylinder or wrap-around plate. Three types of gravure printing include conventional, variable area depth, and direct transfer or variable area. *Standard The student will understand the three types of gravure and will know the advantages and limitations of each.*
42. Letterpress	Letterpress is the oldest and most versatile method of printing. The letterpress process is printing by the relief or raised characters. Letterpress is the only process that can use cast type directly. *Standard The student will describe the letterpress process and understand the advantages and limitations of this graphics system.*
43. Flexography	Flexography is a form of rotary web letterpress incorporating flexible rubber plates and fast-drying solvents or water-based inks. The rubber plates are mounted to the printing cylinder with double-faced adhesive. Printing by this process ranges from decorated tissue to bags, corrugated board, foil, or plastic films. *Standard The student will understand flexograph technology. The student will identify products and materials that may be printed by this process.*
44. Ink Jet and Electronic (Laser) Printing	Ink jet and electronic printing is a plateless printing process. Data representing visual images are stored in digital form in a computer and must be recreated each time the image is reproduced. Computer storage distinguishes electronic and ink jet printing from conventional printing processes because in conventional printing the image is produced only once on a plate, which is then mounted on a press to produce the required number of copies. The ink jet or electronic process is practical for printing variable information such as addresses, letters, and so forth. *Standard The student will describe the operational fundamentals of ink jet and electronic printing technology. The student will identify the products of this technology.*
45. Electrophotographics	Electrophotography is based on the electrostatic transfer of toner to and from a charged photoconductor surface. Plain paper and specially coated paper copiers are currently used. Copiers can have special features such as push-button operation for enlargements or reductions,

45. Electrophotographics *(Continued)*	color copying, two-sided copying, automatic copy feed, copy counting, collating, and even imaging on microfilm. Electrophotography or reprography is widely used in quick printing shops. There are now over 80,000 such installations in the United States. *Standard The student will understand the electrophotographic process. The student will also know the advantages and limitations of this process.*
46. Binding Operations	Binding operations consist of a variety of processes, including preliminary operations such as scoring, perforating, slitting, die cutting, trimming, numbering, and laminating; paper folding; gathering, inserting, and collating; punching and drilling paper; methods of binding; and finishing a bound book. *Standard The student will understand a variety of binding operations.*
47. Career Guidance	A comprehensive guidance program is based on the belief that all students should receive the benefits of a guidance program designed to meet their educational, social, personal, and career needs and that such a program should be an integral part of a school's total educational offering. *Standard Guidance services will be provided to assist all students in determining their interests, aptitudes, and abilities; in selecting the program that meets their career-vocational education goals; and in expanding their individual options.*
48. Gender Equity	A key factor in expanding educational options for all students and preparing them for participation in a technological world is giving students the ability to adapt to the changing attitudes and trends affecting the lives of all students today. *Standard All students will be portrayed as possessing a full range of aptitudes, skills, and emotional expressions.*
49. Leadership	All students will have the opportunity to participate in the leadership development activities that are an integral component of the industrial and technology education courses and programs. Leadership training shall focus on peer-based skills, including the interpersonal, communication, business meeting, and personal business skills necessary for relating successfully to society. *Standard Students will develop the ability to plan together, organize, and carry out worthy activities and projects through the democratic process.*

The model curriculum standards in Visual Communications Technology Standards: Graphics integrate academic core skills, including:

Language Arts

- Reading and comprehending written instruction
- Reading and proofreading copy, using proofreader's marks
- Writing job specifications and production schedules
- Understanding and using technical terms and vocabulary
- Reading and understanding copyright and other governmental regulations

Mathematics

- Computing costs in job estimating
- Understanding the printer's measuring system
- Calculating line length and character count in copyfitting
- Understanding the mathematical relationships of type sizes and styles to page size
- Computing photographic exposure and development times
- Understanding reduction and enlargement calculations
- Applying percentages and ratios

Science

- Understanding the concepts of optics in image development and transfer
- Understanding the chemical characteristics of ink as they relate to surface textures
- Understanding the hazardous materials "flash" point of combustible chemicals
- Understanding the chemical characteristics of film and photosensitive printing plates
- Understanding the basic electronic conversion process in copy machines
- Understanding light intensity as it relates to light-sensitive emulsion
- Understanding the chemical content of developers, fixers, and washes
- Understanding the relationship of temperature to chemical reactions

History–Social Science

- Tracing the development of graphic technologies
- Understanding the impact of trade unions
- Understanding the evolution of hieroglyphic symbols and movable type
- Understanding the social development and impact of printed materials
- Understanding the development and maintenance of good customer, company, and community relations
- Understanding the evolution of photographic processes, materials, and equipment

- Understanding the impact of photography on the cultural and educational development of society

Visual and Performing Arts

- Understanding basic design principles
- Creating acceptable graphic layouts
- Understanding the effect of color in design
- Understanding photography as a nonverbal communication
- Developing an appreciation of creative artistic design

In the past several years, rapid changes in the applications of science and computers have brought about a technical revolution that has significantly altered the way we live and work in our homes, offices, and factories. This has not been a silent revolution. Technological advances have drastically changed the equipment and methods for a growing number of fields, including manufacturing, energy production, information management, health care, agriculture, and transportation. These marked technological breakthroughs—this revolution—is frequently called high technology. Technology will continue to create new jobs, to eliminate some old jobs, and to modify others. Today's technicians are confronted by the diversity, complexity, and rapid evolution of equipment. For example, twenty-five years ago, offices had manual typewriters, and workers who were called on to adjust or repair them were called "typewriter mechanics." They were mechanics in the literal sense—they dealt with the physical principles of mechanical systems. Then electric typewriters—electromechanical devices—began to appear. Repairs required someone who knew not only about mechanics but also at least some of the principles of electrical systems. Soon, electric typewriters were replaced by electronic typewriters that could "remember" a line or a page of what had been typed. These electronic systems are now giving way to more elaborate "word processors," which may include optical character readers and sophisticated ink-jet printers. Such devices are remarkably efficient but cannot be repaired—much less designed and constructed—by a mechanic or an electrician.

Today's office machines are typical of complex modern equipment, which often involves a mixture of mechanical, fluid, electrical, and thermal systems. Technicians who work with, or on, high-tech equipment must have a broad understanding of the technical concepts and principles that govern the behavior of the systems and subsystems that make up this equipment. The skills training in a narrow specialty that has been typical of vocational education in recent years is no longer adequate. The trend throughout the remainder of this century must be to prepare technicians and operators who understand the entire system with which they work and the technical principles of all the complex systems involved—which generally include mechanical, fluid, electrical, and thermal subsystems.

However, teaching technical principles in vocational education should not mean turning to the traditional, theoretical science courses that are designed as prerequisites for academic pursuits in colleges and universities. What is needed is a focus on the practical principles in physical science that help students understand the behavior (and misbehavior) of modern equipment. What is needed is a principles of technology curriculum.

What Is the Principles of Technology Curriculum?

Principles of Technology is a high school curriculum in applied science for vocational-technical students. It is a two-year curriculum covering fourteen units in applied physics. The units are:

1. Force	6. Power	11. Transducers
2. Work	7. Force Transformers	12. Radiation
3. Rate	8. Momentum	13. Optical Systems
4. Resistance	9. Waves and Vibrations	14. Time Constants
5. Energy	10. Energy Converters	

Seven units are taught in the first year and seven more units are taught in the second year. Each unit typically requires 26 class periods of 50 minutes each and shows how a technical concept can be analyzed and applied to equipment and devices in mechanical, fluid, electrical, and thermal energy systems.

Materials developed and tested for a Principles of Technology curriculum include student texts, videocassettes, demonstrations, math labs, hands-on labs, and tests. A teacher's guide for each unit provides suggested presentation strategies, information on how to perform classroom demonstrations, and additional information for problem-solving labs. The Principles of Technology Curriculum was designed to:

- Increase the employability of vocational students
- Emphasize the principles rather than the specifics of technology and provide an understanding of the mathematics associated with these principles
- Increase the appeal of instruction by using an interest-holding instructional system incorporating video presentations, demonstrations, hands-on laboratory exercises, special exercises for students requiring additional help in mathematics, recommendations for "teaching paths" for the teacher and "learning paths" for the students, and a teacher's guide that explains how to orchestrate the learning package
- Maintain the academic rigor needed to meet some of the increased requirements for high school graduation in science

As noted by the National Commission on Secondary Vocational Education, many states have responded to recent criticisms of the secondary school by increasing the number of academic courses required for graduation. The commission recommends that students who do not plan to go to college and who purposefully choose a vocational program be provided with the opportunity to satisfy selected graduation requirements with academically comparable vocational education courses.

How Did the Principles of Technology Curriculum Evolve?

The Principles of Technology curriculum was developed through a cooperative activity of 35 state and provincial education agencies in association with the Agency for Instructional Technology (AIT) and the Center for Occupational Research and Development (CORD). The education agencies are providing approximately $3 million for the creation of the Principles of Technology Program and are testing the curriculum in approximately two schools per state.

Principles of Technology is based on a course entitled "Unified Technical Concepts (UTC) in Physics," which was developed by CORD for postsecondary technical training. The central idea in this course is that a technically valid, unifying approach to physics is beneficial in the study of the basic energy systems—mechanical, fluid, electrical, and thermal. This approach is achieved by demonstrating that concepts such as force, work, rate, and resistance apply and operate analogously in each of the four energy forms. The UTC course is currently being used successfully in associate degree technician programs. UTC exhibits particular effectiveness in:

- Generating student interest
- Helping students retain technical principles
- Making course content relevant and applicable to the technician's field of work

Principles of Technology is an adaptation of the UTC curriculum, tailored to the needs of high school students. The existence of UTC considerably shortened the development time of this new course.

Why Should Principles of Technology Be Taught?

We all live and work in a sophisticated, rapidly changing society that is becoming increasingly dependent upon an understanding of technology to enable us to make informed decisions about governmental policies, about equipment selection for the home or office, and about the operation and maintenance of complex devices and systems. But most science courses in physics and chemistry—written for the 25 percent of high school students who plan to pursue academic degrees at universities—do not present the course material in a manner or at a level that can be mastered or used by the majority of high school students. More than 90 percent of today's high school graduates do not complete a course in physics.

Vocational education has earned a reputation for successfully preparing nonacademically oriented students for employment. These students learn skills that are directed toward a particular occupational objective to be met upon high school graduation. This type of curriculum will continue to be effective for job training in some fields, but it may offer little orientation for the technological society in which we live.

However, to educate modern technicians, we must have a curriculum that not only teaches students skills that will make them currently employable but also provides technical principles that will not become obsolete as equipment and technologies change. Principles of Technology is designed to be a practical science course for industrial and technology education students. It does not replace all the technical courses that relate to job requirements, and it is not an academically oriented science or mathematics course. It is an applied physics course, oriented toward modern technology. Principles of Technology strengthens needed mathematics skills and is designed to complement the existing industrial and technology education curriculum.

Principles of Technology is not an easy course. The scientific content and the academic rigor of the course are carefully sustained, both to provide a high quality of instruction and to meet the goal of fulfilling high school science requirements. Although the course is not easy, pretesting and post-testing in the pilot year indicated that most students achieve significant learning and find the course interesting and useful. Principles of Technology is a course that gives students technological literacy.

Where Should Principles of Technology Curriculum Be Taught?

Principles of Technology is designed to be taught either in comprehensive high schools or in vocational technical centers to students who plan to pursue careers as technicians and who do not plan to enroll in four-year colleges and universities in engineering or science programs. However, field tests have shown that the course is being used successfully for other student populations:

- Vocational students in all fields
- Students in the tenth grade
- Students in an academic (college-bound) track

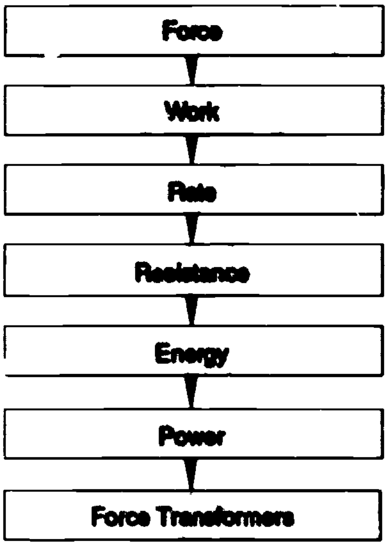
Dale Parnell, president of the American Association of Community and Junior Colleges, has reviewed Principles of Technology and considers it to be the foundation course for a high school "pretech" or associate degree track for technically oriented students who plan to complete their education in two-year postsecondary associate degree programs. CORD is currently developing curricula for "2+2 Articulated Programs," using Principles of Technology as a foundation. Most vocational/technical students who are employed in technical occupations after high school graduation will be required to continue their education and training through company-sponsored programs. Principles of Technology is designed to prepare students for this type of training.

Field-test results indicate that Principles of Technology can be taught successfully in either comprehensive high schools or area vocational schools. Some organizations are considering the use of Principles of Technology for retraining technical workers for high-technology jobs. The course may also be appropriate for remediation in community colleges.

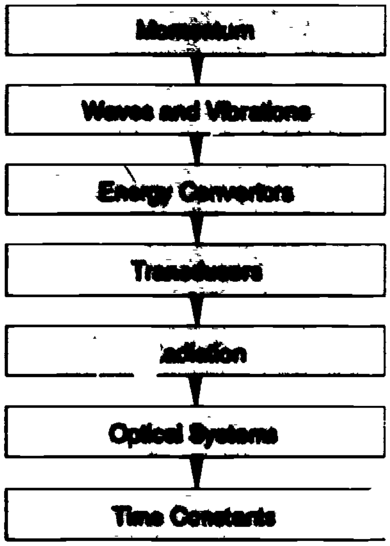
How Should Principles of Technology Be Taught?

These charts show the suggested sequencing of the units:

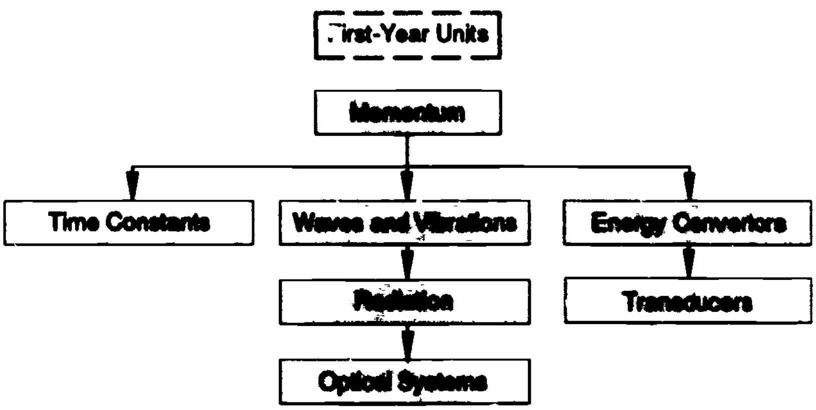
FIRST-YEAR UNITS
Suggested Sequence



SECOND-YEAR UNITS
Numerical Sequence



Second-Year Units* Optional Sequence



*In the second year, Momentum must be taught first. The order of instruction is then flexible, with some exceptions. Radiation must precede Optical Systems; Waves and Vibrations must precede Radiation; Energy Convertors must precede Transducers.

233

The first seven or eight units can be used as a stand-alone course for students who need a one-year applied science course and who require a background in the technical fundamentals. The second year of the course (units 8–14) is most useful to students who plan to continue their study and to work as technicians in advanced-technology occupations.

The suggested teaching plan indicates that the average unit will require the equivalent of 26 class periods of 50 minutes each. These periods are:

- Unit overview class and unit summary class, with readings, video presentations, discussions, and unit test
- Eight class discussions that include reading assignments (four based on subunit video segments and four based on hardware demonstrations)
- Four problem-solving math labs
- Eight hands-on physics labs
- Four review periods (repeating the use of the four subunit video segments)

A considerable variation in the time required for presentation of a unit has been experienced at the field-test sites, depending on the level of student abilities.

Who Should Teach Principles of Technology?

Ideally, Principles of Technology should be taught by a vocational teacher with industrial experience and a strong background (two or three college courses) in physics. Practically speaking, this type of person is atypical, and in most instances alternate selections must be made. The following types of teachers have successfully taught Principles of Technology in the field tests:

- Vocational electronics or electromechanics teachers (some drafting teachers with one or more courses in college physics)
- Industrial arts teachers with one to three courses in college physics
- Physics teachers with some industrial or applications background and an interest in the Principles of Technology course format
- Teams of teachers with a physics teacher doing the classroom (frontal) teaching and math labs and a vocational teacher doing the hands-on labs. The team teaching approach has been found to be particularly successful where the two teachers sit in on each other's classes.

Whichever teacher selection is made, it is extremely important that the new Principles of Technology teacher(s) attend a Principles of Technology Program workshop, be given several weeks planning time prior to the beginning of classes, and be given some release time during the first year of instruction to get labs organized and lesson plans prepared.

What Does a Principles of Technology Program Cost?

Materials. The Industrial and Technology Education Unit, Career-Vocational Education Division, State Department of Education, is a member of the Principles of Technology Consortium. Program participants have the right to make unlimited copies of the print and video materials for use in the program. Participants may also purchase copies of the materials at preferred prices.

Facilities. Principles of Technology can be taught in a high school science laboratory or a vocational lab supplied with 115-volt AC electrical power, water, drain, and gas. Compressed air is useful but not required. It is recommended that five lab stations be provided; however, implementation of the course is possible with two or three lab stations. A videotape player (VHS, Beta, or 3/4-inch [1.9-cm]) and television monitor are required.

Equipment. A complete lab-equipment list for the Principles of Technology labs can be obtained from your state consortium representative or from CORD. The cost of equipment is from $4,000 to $6,000 per lab station for the first year (units 1–7) and approximately $2,000 additional per lab station for the second year (units 8–14). Lab management information, technical facilities requirements, and a detailed equipment listing are available through your state consortium representative at the Industrial and Technology Education Unit, Career-Vocational Education Division, California State Department of Education, 721 Capitol Mall, P.O. Box 944272, Sacramento, CA 94244-2720, (916) 445-6726.

Does Principles of Technology Work in the Classroom?

An extensive pilot test was an integral part of the developmental process for Principles of Technology. Ample evidence indicates that Principles of Technology works in the classroom. Demonstrated results include:

- *Learning gains*—As indicated by several hundred student pre/post-tests, the Principles of Technology units resulted in statistically significant learning gains. These gains were consistent among grade levels and sites and between male and female students.
- *Positive student attitudes*—Students were quite positive about the Principles of Technology units. They indicated that they liked the material, particularly the video programs and the hands-on labs. Students found the material relevant, most indicating that they thought the material was important for them to understand. Again, these findings were consistent among grade levels and sites and between male and female students.
- *Positive teacher attitudes*—Teachers were also positive about the material. Almost all teachers indicated that they felt comfortable teaching Principles of Technology.

These positive findings do not mean that implementing Principles of Technology is easy. The field-test results indicated that certain conditions can enhance the successful implementation of Principles of Technology, as follows:

- *Teacher preparation time*—The majority of teachers reported spending, on average, more than 30 minutes preparing to teach each Principles of Technology class. Several reported more than an hour of preparation. This suggests that adequate preparation time should be allowed for a teacher who is initially implementing Principles of Technology.

- *Teacher background*—Teachers with a more extensive physics background tended to be more successful in implementing Principles of Technology. Although most students demonstrated a learning gain, those students whose teachers had a more extensive physics background tended to have more pronounced learning gains.
- *Class time*—Both a comparison of student test scores to teachers' reports of time spent in class and the teachers' own comments indicate that 50 to 60 minutes per session is optimum.
- *Lab equipment*—The problem that pilot-test teachers most frequently reported was difficulty in getting the lab equipment on time. Since the school's ordering system and the vendor delivery process will likely be time-consuming, lab equipment should be ordered well in advance of anticipated use.

The pilot test has indicated that Principles of Technology does work in the classroom. However, like any educational innovation, Principles of Technology requires hard work. Clearly, a well-coordinated effort among school administrators, counselors, and teachers will help ensure success.

The Curriculum Process Guide has evolved out of the need to provide industrial and technology education teachers with a means of (1) comparing existing curriculum with the state model curriculum standards for industrial and technology education; (2) developing new courses, lesson plans, and other curriculum material, using the curriculum standards; (3) documenting the relationship between industrial and technology education and the academic core curriculum; and (4) providing for the continued refinement of curriculum and instruction.

On completion of the required comparison, many local districts will conclude that their programs are already consistent with the state model. Others will look on the standards as a goal toward which to strive. In any review, however—kindergarten through university—it will be important to shape curriculum content to local student needs.

The process guide is divided into four sections: (1) The Curriculum Comparison Process; (2) Using the State Model to Construct a Course Outline; (3) Using the Model Curriculum Standards to Construct a Lesson Plan; and (4) Teacher-Developed Student Materials.

Contents

The Curriculum Comparison Process

The Curriculum Comparison Process was designed to provide local districts and individual teachers with a format with which to compare local curriculums with state models. In addition to meeting the secondary school requirement for comparing local curriculum with state models, the comparison process will also provide information at all levels about the appropriateness of the local curriculum, the effectiveness of local instruction, any needed modification in the curriculum, and short- and long-term planning. The outcome of the comparison process will also affect the local district's three-year plan development and related quality criteria review process.

Curriculum construction and maintenance is important. This is true not only because of the legal requirement to have a current copy of a course outline for every subject offered on file, but also because students deserve to have access to the most up-to-date knowledge and skills demanded in business and industry today.

The curriculum review process was created to help the industrial and technology educator organize courses into programs and make the required curriculum comparisons. This process should help to promote communication among teachers and administrators. Most importantly, the students can benefit from the opportunity to understand relationships between what they are taking in school and their post-high school occupational goals.

The process begins with the identification of instructional programs, as defined by courses, and ends with an in-depth analysis of how the existing courses compare with the model. Wherever possible, existing methods and materials have been incorporated into this process. The comparison process uses two worksheets that simplify the procedure and produce documents applicable to a variety of needs.

Over the years, school districts have been required to report to the State Department of Education a variety of data relative to the number of students enrolled, completed, and placed from vocational programs. These programs are conducted at the high school and ROP as a series of courses. Each of these courses contributes to the student's knowledge and to the skill development needed to obtain entry-level jobs.

For state reporting purposes, each of these courses has been designated with a California Basic Educational Data System (CBEDS) code and title. For industrial and technology education there are 153 such codes and titles, ranging from Air-Conditioning to Woodworking. The CBEDS code is composed of a four-digit number; industrial and technology education programs are represented by program codes with the numbers 55XX, 56XX, 57XX, 58XX and 59XX.

As a result of the state Superintendent's policy of defining programs as a "sequence of courses" leading to specific student outcomes, the existing CBEDS code structure takes on a second purpose. In addition to serving as a means to report course activity, the CBEDS codes may also be used to define an instructional program. To assist in the task of finding the proper program code, a concise description for each CBEDS code and title has been prepared and included in Appendix A. Also included in Appendix A is a table that shows the connection between the industrial and technology education clusters and CBEDS codes and titles. This table is arranged by seven clusters with assigned CBEDS codes and titles listed under each cluster title.

Form A: Comparing Course Content with the Model Curriculum Standards

The process of comparing local curriculum with the state model begins with the two-sheet form entitled, "Comparing Course Content with the Model Curriculum Standards" (Form A). To complete Form A, four resources are required:

1. The *Industrial and Technology Education Model Curriculum Standards and Program Framework* document
2. A list of courses for the industrial and technology education program to be reviewed (Note: A program title is obtained from reviewing CBEDS's codes and titles—Appendix A.)
3. A course outline for each industrial and technology education course within the program identified in item (2), above
4. Current academic framework and model curriculum standards documents

Form A, "Comparing Course Content with the Model Curriculum Standards," is designed to help organize information from a variety of sources to facilitate its analysis and to record conclusions. A number of benefits accrue from completing a Form A for each course in the selected program. These benefits are:

1. Providing a defined course sequence for the specified indus trial and technology education program (This is an important tool for guiding students in selecting the right course combin ation needed to reach their career goal.)
2. Providing evidence of course content that enhances the academic core curriculum
3. Providing a comparison of the district curriculum with state standards.
4. Providing a mechanism to help keep the district curriculum on a par with state standards

Instructions for Form A

Step 1—Program/Cluster Identification

A. Select a program.
   1. District vocational reports
   2. ROP/C VE-77
   3. Previous district plans
   4. Three-year district plan

B. Study Form A to become familiar with its contents and layout. Note that it is divided into three parts: (1) general identifying information; (2) sequence of courses; and (3) the course/standards comparison documentation.

C. Identify the related industrial and technology education cluster.
   1. Cluster descriptions in the framework (Appendix A)
   2. Similar titles (cluster-program)
   3. Key word or common word analysis
   4. District practice

D. Record identifying information at the top of Form A. (See example below.)

[illegible]

Step 2—Program Course Sequence

A. Identify courses within the program.
   1. Program title/course title relationship
   2. Program description (Appendix A)
   3. District course outlines, ROP/C course outlines, and district course codes, ROP/C VE-77s

B. Arrange courses into program sequence.
   1. Logical learning sequence
   2. Purpose of course; exploratory, skill building, and occupationally specific
   3. District/school policy and/or prerequisite
   4. ROP/C courses

C. Complete the sequence of courses information on Form A.

Sequence of courses (course titles)	CBEDS code	Grade level
1. I SC. DRAFTING	5701	9-12
2. ADVANCED DRAFTING	5702	10-12
3. COMPUTER-AIDED DRAFTING	5705	11-12
4.		

Step 3—Recording Course Outline and Validating Model Curriculum Standards (Step 3 is repeated for each course listed during Step 2.)

A. Select course for comparison to cluster standards.
   1. Check course outline for currency.
      a. Course outline preparation date
      b. Advisory committee
      c. Department review
   2. Check course outline for block/unit organization. (See Appendix C for sample of course outline.)
   3. Correct any discrepancies on prepared, detailed course outline.

B. Record outline.

1. Number column is used for block and unit numbers.
2. Block and unit titles are recorded in course outline column. (This may be a cut-and-paste job.)
3. Use additional sheets for Form A as necessary; record sheet numbers.

See the example from Form A below.

Step 4—Matching Course Outline to State Standards
(Step 4 is repeated for each course listed in the sequence.)

A. Compare block and unit titles with standard titles.
   1. Use model cluster menus.
   2. Use model cluster descriptions.
   3. Use common word analysis.
   4. Match standards with block and/or unit titles.

B. Record standard number and title opposite and on-line with the appropriate block or unit title.

C. Record matches between industrial and technology education standards and academic standards.
   1. Use current academic framework and standards.
   2. Use common word analysis and skill/task analysis to determine matches between curriculum and academic standard.
   3. Check wherever appropriate matches occur on Form A by using page numbers or other identifying codes.

Form B: Summary Comparison of Course Content with State Curriculum Standards

The local curriculum comparison process continues with the completion of Form B, "Summary Comparison of Course Content with State Curriculum Standards." This second step is dependent upon the quality of completed materials described for Form A in this guide.

When the curriculum comparison process is initiated by the local district teacher, it should be noted that every district does not operate every possible industrial and technology education program. During the comparison, therefore, a one-to-one match with every curriculum standard listed in the state model should not be expected.

Furthermore, every district should expect to offer industrial and technology education programs as appropriate to:

1. The size and location of the district
2. The type of industry in the labor market served
3. The availability of facilities and staff

The state Superintendent has suggested that arranging Career-Vocational Education Division courses in a sequential manner leading to a predetermined outcome can be a powerful means of reinforcing the academic core. Given this suggestion, it would appear that in any process to improve curriculum, serious consideration should be given to identification of the course sequence for any Career-Vocational Education Division program operated by the district. Consider the course sequence for the automotive mechanics program described in Appendix B: In this example, industrial and technology education specialization courses are offered during the final two years in the high school; occupationally specific courses are offered through an ROP/C program. While this example suggests articulation with a community college, listing options for the student to follow after leaving high school, it might also include elementary and middle school courses.

Form B, "Summary Comparison of Course Content with State Curriculum Standards" is designed to compare the distribution of standards to the courses that constitute the instructional program. This form is divided in two major parts: (1) identifying information and (2) comparison of standards contained in each of the courses that make up the program. As with Form A, a number of benefits are derived from completing this form. These are:

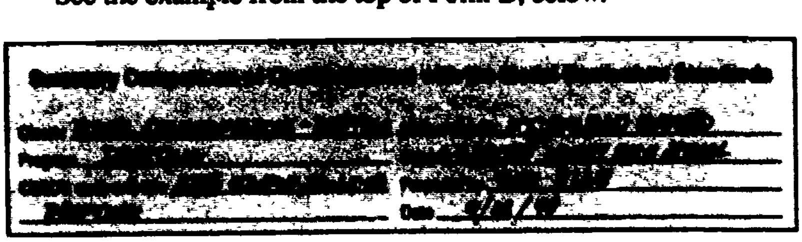
1. Identifying critical cluster standards not addressed in the courses that are in the program sequence
2. Identifying any cluster standard addressed in more than one course
3. Identifying the basis for modifying existing curriculum
4. Identifying the justification for starting new courses
5. Defining information to assist in establishing priorities for the district's three-year plan

Instructions for Form B

Step 1—Completing Identifying Information

A. Study Form B to become familiar with its contents and layout. Note that much of its information can be obtained from the completed Form A.

See the example from the top of Form B, below.



B. From Form A, obtain the model curriculum cluster title and program title and record them on Form B.

C. In the spaces under the heading "Sequence of courses (program)," list the courses containe I in the selected program. (Obtain from Form B.)

D. List related cluster standards. (Use cluster menus in the model.)

Step 2—Recording Cluster Standards Matches with Course Outlines

Using the previously completed Form A, check off each cluster matched to a course outline block or unit title.

1. For every cluster standard indicated on Form A, and using the code letters (bottom of Form B), mark the corresponding course column on Form B.
2. Continue until all courses from Form A have been properly recorded.
3. Take care to line up the code letters so that left-to-right duplication matches occurring between the standard and in more than one course can be easily identified.

See the example from the bottom section of Form B, below.

Code I = Introduction or exploration of standard
P = Primary instruction at this level
R = Review of primary instruction
A = Standard to be added to course of study

Form C: Three-Year Plan for Implementation of Standards

The logical next step in the total curriculum comparison process is to develop some kind of plan for making the modifications indicated by the analysis of the results of completed Forms A and B. Form C was devised to establish a schedule for making the indicated changes.

A number of benefits accrue from completing this form:

1. Establishing priorities for curriculum changes and associated timelines
2. Establishing essential documentation needed for the district's Three-Year Plan for Career-Vocational Educ ion
3. Estaolishing backup documentation needed for budget development

Instructions for Form C

Step 1—Performing Cluster Standard/Program Analysis

A. Check for unnecessary duplication of instruction occurring among multiple courses in the program sequence (examination of Form B).
   1. Review advisory committee recommendations.
   2. Seek departmental consensus.
   3. Seek departmental consensus as identified by the code on Form B.
   4. Consider the purpose of the course in the program sequence.

B. Check for standard omissions (model).
   1. Determine if standards not checked require assignment to one or more courses in the program sequence.
   2. Determine if a new course is required in the sequence.
   3. Consult advisory committee.
   4. Seek department decision.
   5. Use the "A" code to indicate that the standard is to be added to the course curriculum.

Step 2: Recording Conclusions

A. Record the titles of the selected standards, in the left-hand column (use the "A" codes on Form B).

B. Record necessary action for implementation of standard:
   1. Add to existing course (title).
   2. Add new course (title).
   3. Modify existing curriculum.
   4. Delete from course (title).

C. Mark in the appropriate column the year selected for standard implementation.

Three-Year Plan for Implementation of Standards

Cluster ______________________ School district ______________________

Program ______________________ School ______________________

CBEDS code and title ______________________ Prepared by ______________________

______________________ Date ______________________

Sequence of courses (course titles)	School year			Action to be taken
	1980-81	1981-82	1982-83	

Step 3: Implementing the Standards

The completion of Form C is the final step of the curriculum comparison process; what remains now is the actual implementation. Implementation activities may include:

1. Rewriting course outlines to reflect adjustments
2. Writing new course outlines (see Section Two)
3. Ordering essential instructional materials or equipment
4. Modifying facilities
5. Conducting teacher selection and/or staff development
6. Establishing budgets

Form D: Budget Planning for Implementation of Standards

Form D, "Budget Planning for Implementation of Standards," is the last form in the series of forms that make up the curriculum-comparison process. Identifying the equipment, supplies, and services needed to implement a particular standard is critical; administrators and school board members will require this information before making their decisions.

This form is really an extension of Form C. While Form C is designed to answer the questions *when* and *what*, Form D is designed to answer the questions *how much* and *why*.

As with all the previous forms, there are certain benefits to be gained from completing this form:

1. Identifying preliminary cost data for implementing a Model Curriculum Standard
2. Documenting all items needed to be purchased for the implementation of each model curriculum standard
3. Identifying information needed to justify the expenditure of funds

Instructions for Form D

Step 1: Determining What Is Needed and Its Cost

A. As with all the other forms, complete all of the identifying information required in the upper portion of the form; then list the standards to be implemented for the selected budget or school year. All of this information can be obtained from Form C.

B. Identify the equipment, supplies, and services required. This task may be complex or simple, depending on what is actually needed to implement the standard. It may range from preparing the specifications for a new milling machine, its tooling, and the rewiring of the shop to accommodate 220-volt, three-phase power, to simply identifying a new micrometer.

   1. Analyze the cluster statement.
   2. Confer with the vocational education administrator and the business director.
   3. Consult with advisory commi

4. Confer with the chief of facility maintenance.
5. Consult catalogs and/or sales people.

Complete the "Item" and "Funds required" columns.

Step 2: Writing the Justification Statement

The time spent on the task will be directly proportional to your success in obtaining all of the necessary approvals. The more effort expended on this part of the form, the more likely you will be successful. You should not only spend time on the areas discussed in the next paragraph, but you should also explore the various sources of funding. You should be ready to seek funds from sources in addition to the district's general funds.

The language in the particular model curriculum standard and the minutes of advisory committee meetings should be rich resources for this task.

In writing the justification statement, you should consider:

1. The model curriculum standards
2. The goals and competency curriculum statements in course outlines (Form E) and lesson plans (Form F)
3. Catalog descriptive language
4. Vendor statements
5. Advisory committee member statements

Budget Planning for Implementation of Standards

Cluster ____________ School district ____________

Program ____________ School ____________

CBEDS code and title ____________ Prepared by ____________

____________ Date ____________

Item	Selected curriculum standards	Funds required for school year	Justification for funds

249

Form A

Comparison of Course Content with the Model Curriculum Standards

Course ______________________ School district ______________________

Cluster ______________________ School ______________________

Program ______________________ Prepared by ______________________

CBEDS code and title ______________________ Date ______________________

Sequence of courses (course titles)	CBEDS code	Grade level
1.		
2.		
3.		
4.		

No.	Course outline	No.	Model curriculum standard title	Areas of academic enhancement				
				English	History	Mathematics	Science	Visual and Performing Arts

Form A *(continued)*

Comparison of Course Content with the Model Curriculum Standards

Course title ______________________________ Program title ______________________________

				Areas of academic enhancement				
No.	Course outline	No.	Model curriculum standard title	English	History	Mathematics	Science	Visual and performing arts

Form B

Summary Comparison of Course Content with the Model Curriculum Standards

Cluster ______________________ School district ______________________

Program ______________________ School ______________________

CBEDS code and title ______________________ Prepared by ______________________

______________________ Date ______________________

Model curriculum standards	Sequence of courses (program)			
(List menu)				

Code: I = Introduction or exploration of standard
P = Primary instruction at this level
R = Review of primary instruction
A = Standard to be added to course of study

Summary Comparison of Course Content with the Model Curriculum Standards

Program title ______________________________

Model curriculum standards	Sequence of courses (program)			
(List menu)				

Form C

Three-Year Plan for Implementation of Standards

Cluster ____________________ School district ____________________

Program ____________________ School ____________________

CBEDS code and title ____________________ Prepared by ____________________

____________________ Date ____________________

Sequence of courses (course titles)	School year			Action to be taken
	1990-91	1991-92	1992-93	

Form D

Budget Planning for Implementation of Standards

Cluster ____________________ School district ____________________

Program ____________________ School ____________________

CBEDS code and title ____________________ Prepared by ____________________

____________________ Date ____________________

Item	Selected curriculum standards	Funds required for school year	Justification for funds

Using the State Model to Construct a Course Outline

This section sets out a course curriculum documentation procedure. It was included in this guide to help teachers with course curriculum development. The step-by-step process defined in this section may be used to reconstruct an existing course or to create an entirely new one. Course outlines developed in this manner are directly linked to the model and are clearly related to the academic core.

Every school district is required to have on file a current course outline for each course offered to its students. Since this document is generally available, it will serve as the principal means of comparing district curriculum to the model. Course outlines, however, may vary in format or in structure from district to district. Recognizing that these differences in format do exist (to reach a common understanding of the course construction process and to facilitate potential curriculum exchange), a generic course outline, Form E, was developed for the course curriculum construction process.

Model Curriculum Standards, Program Framework, and Process Guide for Industrial and Technology Education

While this document does not prescribe "what" is to be taught "when," it does contain curriculum standards rich in specific examples. The examples include both the technical core and academic core instructional content. However, as set forth in SB 813, the state curriculum standards are intended to serve only as a model; they are not a mandate.

Local high school districts are required to compare their curriculums to the state's model every three years. The *Model Curriculum Standards, Program Framework, and Process Guide for Industrial and Technology Education* represents the strongest possible professional consensus about the instruction that students who pursue these programs should have prior to leaving school. Local districts are therefore urged to make adjustments in their curriculums as identified through the comparison process.

The model has been constructed as a three-level scheme extending from elementary grades through middle grades, high school, and on into postsecondary institutions. The exact grade level for introducing curriculum concepts contained in the model has not been defined because of the grade level differences in the structure of individual school districts, differences in available instructional facilities, and the varying capabilities of teachers.

Model standards are valuable for determining potential program modifications, such as adding or deleting courses or changing existing course content. They are also extremely useful for constructing curriculum for new programs or for facilitating program articulation among grade levels and institutions.

Course Outline

It is important to note that any modification of an existing program, whether adding or deleting subject content to or from a single course or adding an entirely new course, requires appropriate documentation. Likewise, documentation is required for establishing a new program. Whatever the situation work should begin with identifying the appropriate model standards, assigning them to courses, and determining the course sequence within the program. Once all of these details have been determined, program documentation begins. Constructing an individual course outline for each course contained in the program is the accepted documentation methodology.

The process for determining the content of a course involves an analysis of the subject to define what the student is to do with the knowledge or skills after they have been mastered. Other determinants of course content are:

1. Experiences of the teacher
2. Advisory committee suggestions
3. Available instructional resources
4. Purpose of the course within the program

Prior to the availability of the model, constructing a course outline was principally the responsibility of the teacher. The teacher would begin with an idea that would eventually evolve into a listing of the major topics to be included in the course. This listing would often be derived from a new textbook, from technical information, or from discussion with other knowledgeable people.

The circumstances for curriculum planning and development have changed during the past several years. Certain requirements contained in SB 813, local school board policies, and the State Superintendent's opinions and policies have brought significant change. Most notable among these changes is the active promotion of the instructional program concept: a series of articulated, sequenced courses leading to predetermined occupational outcomes. The effective implementation of the program concept requires the involvement of more people and the commitment to look beyond the content of a single course to see the total instructional content in the entire program. Fortunately, the model is a powerful tool for districts to use in this curriculum planning process.

Course Outline Structure

Along with certain identifying information, the course outline must include the course description, course goals, total instructional hours, and the actual topical outline. The structure of the topical outline is hierarchical, in that it begins with a "block title" that denotes the homogeneous subject content of the block. The block title establishes a central theme; for example, "Type Styles" or "Automotive Tools."

The next hierarchical element in the topical outline is the "unit." The unit is a subset or derivative of the block title. It is a narrow instructional topic. When viewed together, all of the units define the total learning content within the block. For example, listed under a block title of "Type Styles" could be such unit titles as "Evolution of Type," "Development of Type Faces," or "Characteristics of Typefaces." As a rule of thumb, there are usually three to nine unit titles assigned to each block title. If more than nine unit titles are required to define the block, perhaps the block title is too broad and should be split into several topics. Unit titles define cohesive instruction and delineate the coordinated sequential learning activity in which the students are to participate. The course outline, then, is just that, an outline of subject matter to be presented throughout the course. The subject matter is listed on the outline in the sequence in which it is to be presented to the students. To help the teacher to keep track of the subject matter, a numbering system is recommended. Since the block title establishes the central theme, it is numbered with an Arabic numeral and followed by a decimal point. Corresponding unit titles are numbered with the same number as their block title, but following the decimal point the unit is assigned its own number. For example, a portion of a course outline, starting with the block title, should look like this:

3.0 Type Styles
- 3.1 Evolution of Type
- 3.2 Development of Typefaces
- 3.3 Characteristics of Typefaces

To help you to visualize this description, this would be a good time to examine a sample course outline; one has been provided in Appendix C. Also, at the end of this section is a blank course outline form.

The Structure of the State Model

With the structure of the course outline now firmly in mind, an examination of the structure of the model is in order. As previously mentioned, the model is divided into three administrative levels. These three levels are:

1. Industrial and technology education for children
2. Industrial and technology education explorations
3. Industrial and technology education specializations

As you can discern, the titles of these administrative levels follow the best principles of career development. They also fit within the philosophy of the State Superintendent as they define a continuum of learning that contributes to the students' understanding of the technological world.

Industrial and technology education specialization is further divided into seven clusters:

1. Construction technology
2. Diversified occupations
3. Electronics technology
4. Manufacturing technology
5. Power, energy, and transportation technology
6. Visual communications technology: drafting
7. Visual communications technology: graphics

The model includes introductory statements, organization and format explanations, and standards. Near the beginning of each section is a table of contents, better titled a ***menu***. The menu is just what you might expect—a listing of standard titles. Each standard includes an introductory statement and the statement of the standard. Following the standards for each cluster are suggestions illustrating how academic standards may be reinforced.

Organizational Considerations

As you begin to construct a course outline, keep in mind the factors that may affect instructional content, including the following:

- The background and capabilities of the potential student population
- The available instructional facilities
- The planned purpose for the course and what its benefit will be to the student
- The amount of instructional time

Other important considerations are the presentation sequence of the instructional blocks and the units contained within each block. The sequence of instruction is typically organized in a manner that permits the least complex material to be presented first. Also, the presentation order is determined by logic, that is, certain topics are presented before others. The types and grades of abrasives, for example, are typically discussed before a demonstration of how to sand wood to a smooth finish.

During the initial course curriculum analysis and development phase, it is recommended that proposed instructional block titles and their unit titles be written on 3-in. × 5-in. (7.6-cm × 12.7-cm) cards. This will enable you to experiment with the sequence of instruction. Once the instructional sequence has been determined, the various blocks can be numbered to denote their proper sequence.

Using the Model to Write a Course Outline

For the rest of this discussion, manufacturing technology will be used as an example. Before proceeding with the explanation, please review the manufacturing technology cluster standards in the model. Note that manufacturing technology includes the following areas:

- General metals
- Bench metals
- Machine shop
- Machine tool
- Production mill
- Production lathe
- Computer numerical control
- Welding
- Sheet metal
- Plastics

As you turn the pages, note descriptions for the various components of manufacturing technology. With this information, the first three items for a course outline can be written. The first of these is the course title. For the purpose of discussion, let us assume that we have need to prepare a course outline for an introductory course in metalworking. Scanning the listing of what is contained in this particular area reveals that the first item, general metals, could be used for the proposed course title.

Grade level can also be established from reading this material. In this case, the recommended level is grade nine or ten. In any case, if this course is part of a comprehensive program, it certainly should be offered at a grade level that allows students the opportunity to take progressively more advanced courses in the program.

As described earlier, the course outline contains a course description. The introduction to manufacturing technology that provided us with the course title and grade level is also rich in language needed to adequately describe course content. This description is worth the time to write carefully so that it can be used in the district's student handbook to attract interested students.

Developing the Course Outline (Form E)

STEP 1: Selecting the Standards to Be Included in the Course

Begin this task by scanning the appropriate menu. As you identify preliminary standards, copy the number and title onto the upper left-hand corner of a 3-in. × 5-in. card, using one card per selected standard.

You need not limit your scanning to the menu for manufacturing technology. You may, for instance, want to consider some instruction in Print Reading (No. 9 under Machine Tool) and Oxygen Acetylene Welding Equipment (No. 9 under Welding).

STEP 2: Verifying the Selected Standards

Now is the time to leave the menu and carefully read each of the standards that you selected from the menu. If the selected standard still seems appropriate, then keep the corresponding 3-in. × 5-in. card; if not, discard the card from your collection of standards.

STEP 3: Defining the Block Title

The block title on a course outline is a concise and descriptive phrase that represents the homogeneous instructional content of a subject. It defines the part of the instruction that focuses on a central theme; for example, "Lubrication System" or "Braking System."

In most instances, the title of the standard can also serve as the block title. In any case, it will certainly provide strong clues as to an appropriate block title. Avoid block titles that are too brief and that therefore may be open to conjecture as to meaning.

Consider Manufacturing Technology Standard No. 5, "Measurement." Keep in mind the previous caution concerning brief block titles. The single word "measurement" does not seem adequate for a block title. After reading through the introductory statement and the statement of the standard and *underlining the key words*, you could select the first phrase, "Accuracy in Measurement," for the block title. But is that truly reflective of the homogeneous content of a block of instruction on measurement in the context of manufacturing technology? Although not specifically mentioned, the word "precision" certainly is implied. Therefore, consider "Precision Measurement" as the block title for this example.

Record your selected title on a 3-in. × 5-in. card. At this point, do not assign a number to your title, as the instructional sequence has not yet been determined.

STEP 4: Identifying the Unit Titles

Units are logical divisions of instruction contained within a block. Each unit is a cohesive segment of instructional activity that contributes to the student's mastery of the total block. There are a number of factors to consider when identifying unit titles for each block:

- The overall goals of the course
- The relationship of the unit to all other instruction within the course
- The grade level of the students
- The instructional time available for the unit
- The available instructional materials, tools, and equipment
- The ability and previous experience of the students
- The experience and professional judgment of the teacher
- The instructional sequence of the unit within the block
- Related occupational licensing or examination requirements

Review the words you underlined while determining the block title. When you are satisfied that you have identified all of the key words, compare your list with the one following:

- Accuracy
- Interpretation
- Dimensions
- Units of measurement
- Measurement systems
- Terminology
- Tolerances
- Variety of measuring instruments
- Fractions
- Decimals
- Mathematical formulas

The words in the above list represent most of the key or major concepts that must be included in the instructional block, "Precision Measurement." At this point, be sure to study the academic core skills enhancement section to glean any concepts that can be incorporated into this block.

Now consider the logical or instructional order in which these concepts should be presented to students. When you decide on both the order and title, record them on the 3-in. × 5-in. card, carefully marking their proper presentation sequence with capital letters. When your block title and unit title sequence is complete, compare it with this one:

0.0 Precision Measurement
  0.1 History of Measurement
  0.2 Units of Measurement
  0.3 Measurement Systems

0.4 Measuring Instruments
0.5 The Mathematics of Measurement
0.6 Measurement Terminology
0.7 Accuracy in Measurement Practice
0.8 Interpretation of Dimension Symbols

Do not be concerned if you have identified more unit titles or have named them differently. The above listing was included only as a guide. The point here is to illustrate the process of using the model to assist with curriculum construction. Proceed with this reasoning process until you have completed all of the block titles you have selected and recorded on the 3-in. × 5-in. cards.

STEP 5: Determining the Instructional Sequence

The sequence of instruction is important and should be reflected by the order of the block titles as they appear on the course outline. You may wish to review the section of this document titled "Organizational Considerations."

Now spread out your 3-in. × 5-in. cards on a table and begin arranging them in what you think is a logical sequence. Review your sequence and number the blocks. Now present the cards to a fellow teacher to consider the sequence and suggest changes. When you have considered all suggestions, make whatever change in the sequence you feel is appropriate. To check for a possible format, examine the sample course outline included in Appendix C. You are now ready to have your first draft of the proposed course outline typed.

STEP 6: Validating the Instructional Content

Make an appropriate number of copies of the proposed course outline and have it reviewed by an advisory committee. As a result of this review, make whatever modifications you deem necessary.

STEP 7: Obtaining Course Approval

Every school district has its own course approval process. It is important to attach the minutes of your advisory committee meeting when submitting this course outline in the approval process. During a presentation to the district curriculum committee, reference should also be made to the fact that the course was developed using the state model.

You may also include Form A, "Comparing Course Content with the Model Curriculum Standards," in the course approval package. This may strengthen the chances to obtain approval, as this form illustrates how the course could enhance academic core skills.

Form E

Course Outline

Cluster ____________________ School ____________________

Program ____________________ District ____________________

CBEDS code ____________________ Prepared by ____________________

CBEDS title ____________________ Date ____________________

Course title ____________________

Course description

Course goals

Total instructional hours ____________

Topical outline

1.0

- 1.1
- 1.2
- 1.3
- 1.4

Using the Model Curriculum Standards to Construct a Lesson Plan

As in any craft, teaching requires the use of the right tools to do the job properly. The basic tools of teaching include the course outline and the lesson plan. In Section Two, the course outline was fully explained. It defines the subject matter to be taught and the sequence in which it is to be presented. The course outline is used to convey to the reader the totality of the subject matter to be taught. The lesson plan tells the teacher what is to be taught during a specific time period. An analogy of this might be a comparison of a map of California to a city map of Fresno. The state map is useful for showing how to travel across the state, but it is not much use for finding your way around Fresno. As with the state map, the course outline shows the overall subject matter content, but it is too general a reference for actually teaching students.

The lesson plan is derived from the course outline. It shows the details of what is to be taught, just as the map of Fresno shows the details for finding one's way around the city. Each of the unit titles appearing on the course outline are to be further defined into teaching units. Each unit title on the course outline becomes one or more lesson plans. The end results of the defining process—expanding unit titles into teaching units—are recorded in a format called a lesson plan.

The purpose of the lesson plan is to tell the teacher how the lesson (subject matter) is to be taught, what is to be taught, what the students are to do to learn the lesson, and how the teacher is to measure the student's progress to ensure that the lesson has been learned. The use of the lesson plan provides for consistency in the delivery of the lesson. The lesson plan has a number of legal implications. Perhaps the most important of these is that the lesson plan represents the evidence of what the teacher has taught. The lesson plan is the primary basis for a teacher evaluation.

Any experienced teacher can describe for you or show you a lesson plan. No two lesson plans will be the same. They will vary in detail and complexity. Because of such a variance in lesson plan format, it is difficult for teachers to exchange curricula. In an effort to promote the curriculum and to enhance the teacher's curriculum construction abilities, the following section on lesson planning has been developed.

Introduction to Lesson Planning

Before jumping into the technical aspects of constructing a lesson plan, let us consider certain tangential but nevertheless crucial issues. California Education Code Section 44662 states that each local school board is to set standards of expected pupil achievement for each grade level and in each area of study. This section further requires the district to evaluate teacher competency as it reasonably relates to:

- Progress of student mastery of the established standards
- Instructional techniques and strategies used by the teacher
- The teacher's adherence to curricular objectives

It is important to note that the Education Code establishes that it is the district's responsibility to set standards, evaluate student progress, monitor the teacher's use of instructional techniques and strategies, and ensure that the teacher adheres to curriculum objectives. When this is put into practice, however, most of these responsibilities are delegated to the teacher. In reality, then, it is up the teacher to set the standards, select the strategy, stay on the subject (curriculum objectives), and measure the student's progress.

Given this background, one can see that the teacher has critical responsibilities for providing a learning situation in which it can be reasonably assumed that the student has opportunities to achieve predetermined standards. The process a teacher goes through to meet these responsibilities is called "lesson planning." The end product of this planning is a formal written document called "the lesson plan."

Experience has shown that there is a direct correlation between a successful lesson presentation and how much time was spent on lesson planning. The more time spent on lesson planning, the easier the lesson goes. Students nearly always react positively to a well-planned lesson. Lesson planning always begins with the teacher answering a series of questions:

1. What is to be taught?
2. What is the best instructional method to use for this topic?
3. What evaluation method is best for this topic?

Determining What Is to Be Taught

The unit title selected from the course outline establishes the broad general area of the subject matter to be covered during the lesson. At this point the unit title may also be the designated "lesson title." Remember, when the course outline was constructed, connections were made to the industrial and technology education model curriculum standards. Maintaining this connection is important, as the language associated with the standard will assist in developing the unit title (lesson title) into the lesson plan. The standard can establish the limits of instruction and provide guidance in determining the scope of detailed information to include in the lesson.

The lesson development process begins with detailing the subject matter by listing, in outline form, all of the pertinent information to be included in the lesson. Again, the wording in the standard can help during this task. The purpose of the outline is to guide the teacher during the class presentation of the unit. The lesson topic, or unit title, will suggest whether this is a specific skill or related knowledge. The identification of this information helps to determine the content of the lesson outline.

Essentially, there are two types of lessons to be presented to students. These are: (1) skill units, and (2) related knowledge units. The lesson title should suggest which type of lesson it will be. The skill units are used to teach students how to do something: to perform a task, use a machine, or calculate a measurement. The purpose of the knowledge unit is to teach the student some essential information needed for decision making relative to the performance of a task. For instance, automotive refinishing requires knowledge about abrasives, their types, and the circumstances in which each type is used. A knowledge unit on abrasives would be critical for a student to have mastered prior to learning how to sand an automobile.

If the lesson topic deals with teaching a skill, the lesson outline becomes a series of short, step-by-step statements. This requires the teacher to carefully analyze the skill to be learned by the student and to reduce the analysis to a series of logical, sequential steps. Each of the statements defining these steps are action-oriented and should, therefore, begin with an action word like *cut*, *measure*, *fasten*, or *adjust*. The results of this effort will be used in the construction of a student "procedure sheet," which will be described in Section Four.

As in outlining a skill to be taught, a "related knowledge" lesson must also be analyzed to determine the key points the teacher is to make during the lesson presentation. A standard topical outline format should be used for the development of this type of lesson plan. If the teacher is uncertain about how to write this type of outline, he or she may consult any textbook on public speaking.

Whether outlining a knowledge unit or a skill unit, it is important for the teacher to understand that the phrases written are to be referred to during the presentation of the lesson. These phrases serve as memory joggers; they should be neither so long that the teacher is tempted to read them to the class nor so short that the teacher will wonder what was meant by the phrase. The outline is the foundation for what the teacher is to present to the students. Each of the outline phrases represents a concept, a principle, or some bit of critical information.

Academic Reinforcement

During this phase of lesson planning it is important to consider any potential relationship the knowledge or skill unit may have to one or more academic model curriculum standards. A number of the tips given in Section One (The Curriculum Comparison Process) can also be applied here. Depending upon which industrial and technology education subject area is included in the lesson plan, consideration should be given to its relationship to one or more of the state academic model curriculum standards.

As the State Department of Education is now updating the academic framework models on a three-year basis, the teacher should be certain to use the most recent version. There are five academic models: English/language arts, history/social science, mathematics, science, and visual and performing arts.

To determine academic core skill enhancement possibilities, select the appropriate academic model and review the document to identify one or more standards that appear to have a relationship to the technical core of the lesson. Carefully read the academic standards you have selected and underline key words. Compare these key words with those contained in your lesson plan and in associated student learning materials. If a reasonable similarity can be seen through this examination, then there is a connection between the two cores that should be noted.

Determining the Instructional Method

An instructional method may be defined as a systematic procedure used by the teacher to present subject matter to students. An instructional or teaching method is a strategy used to present either new skills or new information. While there are numerous instructional methods, including variations and/or combinations of one or more of the following, only four basic methods will be discussed here:

1. Demonstration: the showing method
2. Laboratory: the job or problem-solving method
3. Lecture: the telling method
4. Discussion: the consensus or group decision method

The demonstration teaching method is used primarily for presenting to students the manipulative skills they will need for future employment. The laboratory teaching method provides the student with the opportunity to practice skills in a protected environment. It is essential for the industrial and technology education teacher to be a master in the use of these two instructional methods.

The lecture and discussion methods are used to disseminate related or technical knowledge. The discussion teaching method is used as a controlled means to draw from class members what they know about a particular topic. The discussion method facilitates the pooling of information from the individual members of the class and is a useful tool in obtaining class consensus.

The Demonstration Teaching Method

Because using one's vision is an efficient way to learn, demonstration teaching is an important methodology. While lecture and questions are associated with this teaching method, it remains primarily characterized by the teacher showing and the student watching.

Demonstration teaching is essential in illustrating how mechanical parts work in relation to each other and how to perform manipulative operations. Various scientific and technical principles pertaining to job skills are easily demonstrated. The successful demonstration lesson depends on careful attention to the following details:

- Safety: Because students are learning what they are seeing during the demonstration, the teacher also has an opportunity to demonstrate safe working procedures.
- Quality: The quality of work produced during the demonstration is what the student will perceive as acceptable. Therefore, the teacher must always be certain to maintain at least minimum standards of performance during the demonstration.
- View: The success of the demonstration method depends on the student's ability to see the progress of the work as the teacher performs it. The optimal observation position for the students is

one that affords the same viewing angle students would have if they were doing the work.

- Pace: The pace of the demonstration is critical for the students to comprehend what they are seeing. The demonstration should proceed in a step-by-step pace to ensure that the students are following the procedure.
- Introduction: Students must be prepared for each demonstration in order to remove any uncertainty about its significance. A concise introduction will help the student to focus on the demonstration instead of wondering, "What is the teacher doing now?"

The Laboratory Teaching Method

In the laboratory method, students learn by doing. This method is used to closely simulate the workplace. To accomplish this, adequately equipped facilities and student work stations are required. The laboratory method is used to replicate actual tools, equipment, materials, and processes used in the associated industry. Lessons using this method are usually preceded by lessons employing the demonstration method.

In the laboratory method, students perform assigned tasks. These tasks may vary in complexity and may include solving a problem, completing an assigned job, and performing an experiment or simple exercise. These tasks may be classified into two types: exercises and jobs.

The exercise is an activity designed by a teacher to give students practice in developing a single skill. For example, exercises may include sharpening a drill bit, squaring stock, or drilling holes. The student performs the exercise until the desired proficiency is acquired. Exercise tasks are useful for developing specific skills, but they can become boring and tedious to the student.

The job is more inclusive than the exercise. The job involves a complete task, more closely resembling the work performed in industry. Examples of jobs include: aligning an automobile front end, stuffing a circuit board, and hanging a door. The assignment of a job has an inherent interest and appeal to the student. Both exercises and jobs have their purposes and limitations.

The four main functions of the laboratory teaching method are as follows:

1. Providing students with opportunities to develop and practice skills through exercises and jobs
2. Reinforcing learning through the application of information or knowledge to a job
3. Providing opportunities for students to acquire new knowledge and understanding
4. Providing opportunities for students to develop occupational work habits

The laboratory method is a multisensory approach to learning, in which students are able to hear, see, touch, smell, and, in some instances, taste as they learn. When the laboratory method is used in conjunction with other teaching methods, it serves as the application step on the lesson plan. (This is described later in this section under the heading "The Four-Step Lesson Plan.")

The Lecture Teaching Method

The lecture teaching method is used to tell about or explain something. Beginning teachers often make the mistake of lecturing too much. There are surprising limits to what and how much students can learn by listening. Experienced teachers realize that student learning, not teaching, is the objective of instruction.

Despite its drawbacks, the lecture method is still useful for presenting certain related units of instruction. Such topics as relief angles of cutting tools, psychological aspects of safety, selection of the proper-size fastener, and the types and grades of abrasives are all appropriate for presentation through the lecture teaching method.

Whatever the topic, a considerable amount of planning is essential if the presentation is to be effective. Consider the following points:

1. Limit the lecture to a few basic ideas or concepts. Cover only the essential points, and do not wander off the subject. Keep straight lecture time to a maximum of 20 minutes.
2. Prior to the beginning of the lecture, see to the comfort of the students. Check the room ventilation, lighting, arrangement of student seating, and other factors affecting student comfort.
3. Deliver the lecture in a conversational tone, avoiding overly formal language. Use good posture and voice tone, and keep eye contact with the students.
4. Insert humor into the lecture. Give examples and use analogies to help promote student interest and attention.
5. Wherever possible, use visual aids to illustrate key points. Stimulate student interest through the use of charts, models, pictures, or actual tools, machines, or materials.
6. Pause from time to time to invite questions or to ask a few questions of selected students.

Although not the most effective teaching method, the lecture is still an important teaching tool. Using the suggestions described here will help to ensure the delivery of a successful lesson.

The Discussion Teaching Method

In contrast to the lecture method, where the teacher tells the class what they are to learn, the discussion method is used to draw from the class what a few of its members may already know. This method of teaching only works when at least some of the class already has some knowledge of the subject. The uses of the discussion teaching method are to (1) pool information from the individual members of the class and (2) determine if there is a class consensus on a given subject.

A class conducted using the discussion method consists of an orderly exchange of student ideas, thoughts, and background. A lesson conducted in this manner must lead to a specific instructional goal. It is not an easy task to plan and lead a lesson that uses the discussion method and that results in both active student participation and the realization of a desired outcome. For assistance in this task, consider the following suggestions:

Planning

1. Determine the desired outcome of the lesson.
2. Establish a time limit. Keep in mind the size of the class and the complexity of the issue to be discussed.
3. Plan an introduction to the discussion to set the stage, to establish ground rules for the discussion, and to start it off on the right track.
4. Prepare the discussion questions, designing them to focus attention, narrow the topic, and stimulate interest.

Leading the Discussion

1. Begin by stating the procedure for the students to follow. This should include:
   a. How to make comments in an orderly manner
   b. How to signal for recognition to speak
   c. How participants will take part
   d. A method for recording the proceedings
2. Direct questions to specific students; do not interject ideas or solutions at this time.
3. Keep the discussion moving, stay on the topic, and bring all students into the discussion.
4. Record and display the main points. This helps with the summary and to resolve any misconceptions.
5. End the lesson with a summary of the key points, stating definite conclusions.

Properly conducted, this type of lesson is important for developing leadership and other personal student qualities. The discussion teaching method is useful for teaching career concepts, worker relationships, and other issues concerning interpersonal relationships.

Defining Student Performance

The model defines minimum levels of student expectations. These standards were written in a general way to permit their adaptation to the local instructional setting. The level of focus the teacher uses for the presentation of a standard and the subsequent expectation for student mastery of the standard depends on numerous factors, which may include the teacher's background knowledge, the availability of equipment and supplies, and the opinion of the local Industry Advisory Committee.

Whatever the level of presentation, the teacher must still establish the expected degree of student mastery of the pertinent standard. This involves two steps: (1) determining if the standard needs to be divided into several parts, and (2) converting the standard or its parts to competency statements. To illustrate this process, consider Construction Technology Standard Number 7: "Measurement/Layout." The statement for this standard is: "The student will be proficient in the reading of a rule to 1/16 in. (1.6 cm). He/she will be able to transfer the measurements from the plan to the project and to apply proper layout procedures."

This standard, like most of the other standards, can be divided into two or more competency statements. In this particular example, the standard can be divided into two competencies. One competency could pertain to accurately reading a carpenter's rule; the other could relate to determining a measurement from a plan and laying it out on a piece of stock. Before proceeding with this illustration, it is well to review some of the considerations that must be made when writing a competency statement.

Writing a Competency Statement

Perhaps the best way to start writing a competency statement is to ask yourself, What do I have to say to explain precisely what the student is to do, under what circumstances it is to be done, and how well it is to be performed? When written, the competency statement must answer these questions: *Who is to do what, under what conditions, and how well?*

Correctly written competency statements will (1) describe what the student is able to do (task) as a result of the instruction; (2) define the conditions under which the task is to be performed; and (3) set the criteria that will suggest the minimum level of achievement necessary for a satisfactory student performance.

It should be noted that some competencies specify a critical thinking ability, while others may require the student to demonstrate computational or manipulative tasks. Competency statements usually start with the phrase, "The student will be able to ...." Then the task is described. For instance, if the student is to identify tools, the competency could be stated:

1. The student will be able to recognize the names of tools from a prepared list.

The above is not as clear a statement as it could be, since it does not specify what kind of list, that is, whether it contains tool names in addition to other names; also, it does not specify whether the student must recognize all tool names or if some percent of the total would be satisfactory. An improved statement might be:

2. The student will be able to recognize at least 18 of 20 tool names contained in a list of 40 items commonly found around the classroom.

Another statement for this competency might be:

3. Given a list of 40 items commonly found in the laboratory, the student will be able to recognize 18 of 20 names of tools included on the list.

Although these are very elementary examples of competency statements, they will serve to give the reader some perspective about competency statement construction. At this time, redirect your attention to the standard from the construction technology cluster for measurement. As was previously discussed, and using the techniques just described, the standard may be expressed in two competency statements. For example:

1. After two hours of instruction, and given five pieces of stock of differing lengths, the student will be able to measure the

correct length (to the nearest plus or minus 1/16 inch of each piece).

2. Given a house plan, stock, and measuring tools, the student will be able to lay out the sill plate for the south master bedroom wall, marking all stud locations with an accuracy of plus or minus 1/16 inch.

The following list of sample competency statement elements may be useful to a teacher faced with writing competency statements for lesson plans.

Elements of Competency Statements

Conditions

Without reference to outside materials,
With the aid of a reference book,
With the aid of class notes,
Given the proper tools and measuring instruments,
In a ten minute period,
With a supply of nails and shingles,

Tasks

Answer, Apply, Arrange, Assemble, Build, Calculate, Compare, Compose, Complete, Conduct, Construct, Convert, Correlate, Demonstrate, Describe, Develop, Differentiate, Draw, Evaluate, Fix, Formulate, Identify, Interpret, List, Maintain, Make, Measure, Operate, Plan, Provide, Quantify, Read, Recite, Repair, Select, Shape, Sketch, Solve, Test, Troubleshoot, Use, Write

Performance Criteria

Perform with an accuracy of plus or minus 1/16 inch.
Identify ten of the 12 principles.
Analyze correctly to within a 5 percent tolerance.

Instructional Levels

In addition to determining what to teach, good lesson planning requires that some thought be given to the depth or detail of instruction. For instance, an electronics technician must know something about the characteristics and types of solder (related knowledge unit) and how to solder connections according to specifications (skill unit), but the technician need not know the chemical or physical properties of solder that a metallurgist would need for researching the conductivity of solder. This type of instructional analysis—determining the detail or depth of knowledge—is referred to as "Levels of Instruction."

During the 1930s an educational researcher, Benjamin Bloom, developed a taxonomy to describe learning levels. Bloom's taxonomy was adapted for use by trade and industry educators, and this adaptation is still useful to industrial and technology education teachers. The modified taxonomy established three levels of learning to help describe the depth of instruction required for prospective workers enrolled in job-specific instructional programs. This three-stage taxonomy should prove useful for curriculum development.

Level 1: Recognition/Remembering Facts

Characterized by:

1. Remembering facts
2. Recognizing items in response to prompts
3. Matching items to establish relationships
4. Classifying ideas and making generalizations
5. Following written and oral instructions
6. Demonstrating perceptual awareness in motor-skill activity from cues

Examples:

1. Identifying alloys used to make high-speed drill bits
2. Matching characteristics of dry-cleaning agents with their names
3. Classifying electronic components according to their functions and values
4. Selecting all needed tools to complete a given task
5. Locating specifications in a technical manual

Level 2: Recall

Characterized by:

1. Recalling specific information
2. Interpreting diagrams, drawings, blueprints, tables, symbols, and graphs
3. Translating mathematical symbols into verbal statements and vice versa
4. Performing motor skills of limited duration, but having durable qualities, complemented by guided response

Examples:

1. Repacking and adjusting automobile front-wheel bearings according to an instruction manual
2. Selecting and installing the proper wire according to a wire size table and in accordance with local building codes
3. Making adjustments to an ignition system based on interpretation of test equipment and engine specifications
4. Restating ideas obtained from technical documents

Level 3: Reorganization

Characterized by:

1. Recognizing common factors that apply to a new problem or situation
2. Transferring earlier learning to the solution of new situations
3. Having the ability to analyze and/or synthesize in order to maintain continual operation of an intricate system and its components
4. Weighing the consequences resulting from any action taken
5. Planning and performing all specified task-oriented manipulations

Examples:

1. Designing a structural complex incorporating loads, codes, and economic considerations
2. Determining internal and external performance characteristics of a system and formulating an equivalent model

3. Designing and manufacturing a mass production item that has parts that move
4. Deducing that an emergency exists from an analysis of instrumentation readings on a boiler

Determining the Method for Student Measurement (Student Evaluation)

If a subject is worth teaching, instruction must include evaluation to determine what the student has learned. This is particularly true for teaching industrial and technology education subjects because of the continuing need to place students in entry-level jobs. Placement is the ultimate student evaluation, for if the student cannot perform, the employer will not hire. Therefore, student evaluation is a critical part of each lesson.

Student evaluation measures the amount of learning that has occurred or the level of mastery of some specific skill or knowledge. Books have been written on this subject, so the intent here is simply to point out that:

1. Evaluation is part of the teaching and learning process; it requires time and planning.
2. Assigning grades is a legal requirement and is the responsibility of the teacher. In those cases where there is a formal challenge to the grade assigned to a student, the teacher must have some defensible evaluative methodology.
3. Evaluation is the formal time a teacher spends to verify that the student has met the minimum requirements specified in the lesson competency statement.
4. Evaluation is the broad and comprehensive value judgment the teacher makes of the student; it constitutes the sum total of the student's progress toward competency for a particular lesson, or period of time: quarter, semester, or school year.

A comprehensive evaluation incorporates numerous factors involving the verification of student performance against set standards. Testing is a critical part of student evaluation. Oftentimes, setting a baseline or benchmark of the student's knowledge or skill in a particular subject is important; this is accomplished by administering a pretest and a post-test. These tests are of value in determining student progress. They may be conducted in a variety of forms: written, performance, and observation.

- *The written test*—The written test is used to measure a student's knowledge of a particular subject. The questions may be presented in various formats, including essay, true-or-false, or multiple choice. Whatever the format, the questions must be carefully crafted to promote student reasoning and thought. The questions must be derived directly from subject matter presented to the student, and they must serve as a measurement of the student's mastery of the requirements in the lesson's competency statement.
- *The performance test*—The numerous jobs related to a technical industry require a vast number of manipulative skills, and these

skills must be performed under specific working conditions. The purpose of the performance test is to replicate, so far as possible, the conditions of industry and to measure the student's ability to perform required tasks. Each student performs the exercise under rigidly controlled conditions. In this manner the teacher is able to make valid and reliable judgments about the progress of each student.

- *Teacher observation*—While requiring some definable criteria, teacher observation is perhaps the least objective of the three types of tests. This method should be used sparingly because it is the least defensible when challenged and is also the most difficult to document. It is useful, however, for checking the student's performance of a single skill. This method is used on a day-to-day basis in instances such as checking a machine setup before turning on the power or checking a measurement before the cut is made.

Determining Instructional Time

No matter how it is viewed, teaching is a matter of allocating instructional time to a subject. Such factors as the number of days in a school year, the number of school holidays, the length of the class period, and assembly schedules are all major considerations in determining the allocation of instructional time to spend on a particular subject. Other significant factors for allocating class time include the learning level or student mastery assigned to the subject and the complexity of the subject.

The course outline was discussed earlier in this document (in Section Two). During the construction of a course outline, a gross time allocation is made. This time allocation is based on (1) the total number of instructional hours available to the course and (2) the distribution of instructional hours to each block on the course outline.

If the course has not been taught before, estimating the amount of time needed for each topic will be difficult. Therefore, the teacher must make the best judgment possible, keeping track of time expended on each topic. Care must be taken to note the time expended and the remaining amount of instructional time to ensure that all critical topics are presented to the students.

As the teacher prepares each lesson, time to be spent on each activity must be accounted for; for instance, student attendance, class announcements, subject introduction, presentation of the subject, distribution of student instructional materials and tests, student application of the subject matter, and student evaluation all take time from the class period. By considering student learning rates, the degree of mastery required, and the complexity of the subject matter, the teacher assigns the time to be expended on each item. When the lesson plan is completed, the total time for each activity is added up and compared with the class period. If too much time has been allocated, each activity must be reconsidered and adjusted to fit the class period. The teacher should proceed through each instructional unit, developing the lesson plan and allocating time to each student activity. In this manner the initial time assigned to the subject-matter block on the course outline may be adjusted where appropriate.

The Four-Step Lesson Plan

Now that each of the major aspects of lesson planning has been discussed, it is time to consider how to capture, in some logical format, the results of the planning effort. The suggested format is called a four-step lesson plan. This type of lesson format has been modified to accommodate the need to connect the lesson plan to both the technical core and the academic core. Provisions have also been made to facilitate the exchange of curricula among teachers, local districts, ROP/Cs, and California Industrial and Technology Education Consortium (CITEC) centers. As a result, the identifying data specified in the four-step plan is more extensive than that which may be required locally.

The four-step lesson plan is a simple but logical process to present what is to be learned to students. Each bit of instruction must be organized so students can internalize it and put it to use. The four-step organization offers the teacher a strategy for effective lesson presentation. The four steps are (1) motivation, (2) presentation, (3) application, and (4) evaluation.

Up to this point, the primary focus of this section has been lesson planning. Now the focus is shifting to lesson delivery. However, another important step must be taken before it is lost in this shift to lesson delivery, and that step is preparation . Preparation includes acquiring necessary materials—the media, aids, tools, and stock—to be used, and making all of the physical arrangements for the presentation and its reception by the students. The preparation step also includes checking and arranging the demonstration facilities: lighting, seating, and special equipment such as projectors, models, or specimens. Preparation is essential to the success of each of the four steps and must be completed prior to beginning the actual lesson.

The Four Steps

Step 1: Motivation

Motivation is the process of focusing student attention on, and arousing interest in, the subject to be learned. Motivation is a critical step. If student interest in the lesson is not generated, the rest of the instructional process will fail. Student motivation cannot be assumed, even when students voluntarily enroll in the class. When starting a group presentation, a teacher faces a class of mixed interest, variable backgrounds, associated moods, and divergent thoughts. The teacher's challenge and first concern is to redirect the students' thoughts and to focus their attention on the subject matter to be presented, using the following motivation techniques:

- *Getting Attention*—Student attention can be captured in many ways. Standing in front of the class and waiting expectantly for a few seconds may work; writing a word or phrase on the chalkboard may also serve. Turning off the lights and starting a videotape, setting an object on a demonstration table, or rapping the desk with a ruler may also work to gain the attention of the students. The same attention-getting technique may work most of the time; however, a varied approach to the class usually works better.

- *Teacher Enthusiasm*—Students can and do sense the teacher's interest in the subject matter. If the teacher starts the lesson as if it is a necessary evil or a boring subject, this impression transfers to the students and the result of the lesson will be less than successful. The teacher's own apparent interest and enthusiasm is an important ingredient in student motivation. A dynamic teacher, through mannerisms, expressions, and approach, will generate the desired student interest. A positive teacher approach encourages the class to feel that the subject is interesting, important, challenging, and possible to learn.
- *Relevance of the Subject*—To maintain motivation, students must see that the subject matter being presented is of value and pertinent to their needs and goals. There is a direct relationship between motivation and the students' ability to make connections between their immediate goals and the usefulness of the subject matter. The teacher must clearly show the importance of each topic or task. At the least-complex level, this may be done by showing the student how a particular bit of know-how will make the job easier to accomplish. Another approach is to emphasize the increased employability or earning power a particular knowledge or skill will give to the worker. Whatever the approach, the student must see the relevance of the lesson to him or her and to his or her success.

Step 2: Presentation

The presentation is the process of bringing before the students' minds, offering for their consideration, or setting forth in words, actions, pictures, or symbols, a new skill or concept. To put the emphasis on learning, teachers should think of this step as a time for students to absorb, receive, and/or assimilate the new knowledge or skill.

Various presentation techniques were discussed previously; however, it is important to realize that a good lesson presentation requires a clear purpose and concise, logically organized facts and ideas. Proper pacing of the presentation so that the learning material is given at an appropriate rate is an absolute necessity. As described later (under Teacher-Developed Student Materials), supplementary provisions in the lesson presentation can be made for both fast and slow students to enhance the possibility of reaching most of the students in the class.

Step 3: Application

During the application step, students are provided the opportunity to put to use the skill, information, or concept put forth during the presentation. "Use" is the key concept in the application step. To ensure that the learning will "take," students must be given the opportunity to use the skill or knowledge as soon as possible after its presentation. The application process should not be thought of as a one-shot opportunity. For long-term retention, a period of constant practice must be provided. Depending on the subject matter of the lesson, the application step can be achieved through controlled student exercises. This can be expedited through student assignments, jobs or operations, or experiment worksheets. As described in the next section, these sheets can direct the student through the performance of a particular skill or research problem. Essential to the success of the application step is the availability of all materials, tools, equipment, and other resource materials in adequate quantity to serve the needs of the class.

Step 4: Evaluation

Verifying student learning is the proof that lesson competency has been achieved. Evaluation is the formal process the teacher performs to judge or rate the student's progress on each separate activity or unit of instruction. The obvious technique for performing student evaluation is some type of test. In industrial and technology education classes, a primary means of testing is teacher observation of student performance and the assessment of a finished product. Day-to-day assessment of student understanding can be accomplished through oral questioning. Careful observation of the student's reaction to the question is important, because facial expressions and other body movements can reveal the degree of understanding or confusion.

In the final analysis, student evaluation is a continuous process, requiring careful documentation and the use of multiple techniques.

Completing the Lesson Plan

On the last two pages of this section, two forms—the Lesson Plan Work Sheet (Form F) and the Four-Step Lesson Plan (Form G)—are provided for your reference. Do not be alarmed when you first see them; they are not as complex as they may seem. The needs brought about by legal mandates, the linking of the academic core curriculum to the technical core, and the desire to establish an effective means of exchanging curricula require specific types of identifying information. The forms also provide spaces in which to write the results of the lesson-planning effort. The following six activities have been prepared to assist and guide you in completing these forms.

Activity One: Completing the Identifying Information Section of the Lesson Plan Work Sheet (Form F)

The top section of the Lesson Plan Work Sheet simply requires that you fill in the requested information. Much of this information was compiled during the curriculum comparison process; for instance, the framework cluster, curriculum standard, course title, and program title are on either Form A or Form B of that process. The lesson title, unit title, and block title are taken directly from the course outline. (See Section Two.) The only remaining information needed to complete this part of the form is the grade level at which the course is to be offered, the name of the teacher who prepared the lesson plan, and the date the plan was completed. This information will permit maintenance of the industrial and technology education curriculum framework and model curriculum standards and will also permit the collection, storage, and distribution of curricula by and through the CITEC centers.

Activity Two: Identifying the Teaching Method

After reviewing the discussion "Determining the Instructional Method," which was presented earlier in this section, check the appropriate selection on the Lesson Plan Work Sheet.

Activity Three: Identifying the Instructional Level

To establish the instructional level, review the subsection "Instructional Levels" in the discussion on "Defining Student Performance." The instructional level is best determined by the teacher after the presentation outline is completed. The analysis that goes into the presentation outline should help to establish the instructional level. Another important factor to consider during this activity is the student competency statement. Once the instructional level is determined, check the appropriate selection on the Lesson Plan Work Sheet.

Activity Four: Completing the Competency Statement

For assistance in completing, the competency statement on the work sheet, refer to the subsection "Writing a Competency Statement" in the discussion on "Defining Student Performance."

Activity Five: Documenting the Student Motivation Step in the Four-Step Lesson Plan (Form G)

Documenting the student motivation step in the four-step lesson plan requires only a note prepared in sufficient detail to guide the teacher when the lesson is being presented. The brief note should include a reference to previous lessons that have a direct connection with the lesson to be presented and to future student goals. The motivation step should also refer to the competency statement to show what is expected of the student for the successful completion of the lesson.

Activity Six: Completing the Main Body of the Four-Step Lesson Plan

The main body of the four-step lesson plan consists of the "Presentation Outline," "Time," and "Academic Reinforcement" columns on Form G, which are to be read from left to right. If the contents in columns are properly aligned, information in one column is related to that listed in the other columns. In this manner, a teacher using the lesson plan can see the amount of time allocated to the presentation outline and what academic reinforcement is to occur.

The first two columns, "Presentation Outline" and "Time," have been discussed in previous paragraphs in this section under the titles "Determining What Is to Be Taught" and "Determining Instructional Time." The presentation outline is intended to serve as a guide for the teacher as the lesson is presented. Phrases in the outline should not be so complete as to tempt the teacher to read them to the class. The outline is a prompt for the teacher; the phrases are to suggest to the teacher key points to make during the lesson. It is up to the teacher to put into his or her own words the comprehensive explanation of these key points.

The "Time" column is to be used to record hours or minutes allocated to expend on each of the key points in the presentation outline. The total time spent here, along with that allocated to the motivation, application, and evaluation steps, is not to exceed the instructional period or periods devoted to the lesson.

The third column, "Academic Reinforcement," has been included to document places where industrial and technology education subject matter is directly related to an academic model curriculum standard. The academic area and standard number are to be recorded in this column. A review of the previous paragraphs dealing with academic reinforcement may assist in completing this information.

The space on the lesson plan labeled "Student Application" is used to record the name of the exercise or activity the student is to perform. A review of the paragraphs in "The Four-Step Lesson Plan" and "Step 3: Application" earlier in this section will help the teacher complete this part of the four-step plan. These activities are usually given to the student in the form of instruction sheets, which are describe later in Section Four, "Teacher-Developed Student Materials." Remember to estimate the amount of time allocated to the application step and record it in the space provided. The application step should be allocated the largest portion of the time available for the lesson.

The next portion of the lesson plan, "Student Evaluation," can best be completed after reviewir .he earlier paragraphs titled "Determining the Method for Student Measurement" and "Step 4: Evaluation." After this review, it should be possible to simply check the appropriate places and fill in the time allocation for evaluation.

The teaching aids section of Form G is to be used for recording any supplementary aids to be used during the lesson. The complete titles and ordering addresses for any needed films or videotapes should be included here. Also, any tools, equipment, or other items needed to present the lesson should be listed.

Form F

Lesson Plan Worksheet

I. Lesson title ______________________________

II. Identifying information

- Framework cluster ______________________________
- Framework standard:
- Program title ______________
- Course title ______________
- Unit title ______________
- Block title ______________
- Grade level ______________
- Prepared by ______________
- Date ______________

III. Lesson planning

- *Lesson type*
  - Skill development ______
  - Related knowledge ______
- *Instructional levels*
  1. Recognition/recall facts ______
  2. Recall ______
  3. Reorganization ______
- *Instructional method*
  - Demonstration ______
  - Laboratory ______
  - Lecture ______
  - Discussion ______
- *Total required instructional time*

  ____

IV. Competency statement

287

Form G

Four-Step Lesson Plan

I. Step one: student motivation

II. Step two: lesson presentation

Presentation outline	*Time*	*Academic reinforcement (academic area)**

III. Step three: student application

1. Assignment sheet .... __________
2. Information sheet............................ __________
3. Job or procedure sheet .... __________
4. Occupational appreciation sheet ..... __________
5. Field trip guide .... __________
6. Media guide .... __________

IV. Step four: student evaluation

1. Written test .... ______
2. Performance test .... ______
3. Teacher observation .... ______

V. Required teaching aids and/or demonstration equipment

*Academic reinforcement: History/social science; Science; English/language arts; Mathematics; Visual and performing arts

Teacher-Developed Student Materials

Teacher-developed student materials come in a variety of creative forms. Six companion formats for teacher-made materials, designed for use in conjunction with the lesson-plan format described in Section Three, are described in the present section. These six materials—student instruction sheets—are as follows: (1) the Assignment Sheet; (2) the Information Sheet; (3) the Procedure Sheet; (4) the Media Guide; (5) the Occupational Appreciation Sheet; and (6) the Industry Tour Guide. As you review these work sheets, you will note that each serves a different purpose; some lend themselves well to related knowledge, while others serve as guides for mastering a particular skill. These six student instruction sheets may be used singly or in combination as companion curriculum materials to implement "Step 3: Application" of the four-step lesson plan.

Instruction Sheets

Instruction sheets are of many types and formats. All sheets, however, have a number of things in common. These include: (1) the title of the instruction sheet; (2) the course; (3) the teacher's name; (4) the student's name; and (5) assignment and due dates. Other information items include (6) an introduction to the sheet (an explanation of its purpose) and (7) a stated relationship to the specific competency being addressed. Every instruction sheet should also contain some carefully structured test questions.

Model Curriculum Standards/Instruction Sheet Relationship

Instruction sheets included in this section are designed to link directly to completed lesson plans (Section Three of this guide). Lesson plans are a direct reference to a carefully developed course outline (Section Two), which has been compared, as mandated, with the California *Model Curriculum Standards and Program Framework for Industrial and Technology Education*. Space has been provided on each student instruction sheet to identify the relationship of the instruction sheet to the program framework and curriculum standards. Each of these information items—Cluster Title, Model Standard No. and Title, and Objective/Competency Statement—is critical to the comparison of local curriculum to the model. These items will also be the principal means of classifying, exchanging, and modifying all industrial and technology education curriculum standards and related materials.

Standard Identification

To locate the curriculum standard (number, title, and statement), it will be necessary to refer to the appropriate list of standards presented earlier in this guide. With a copy of the standards appropriate to the course under development, the teacher may complete the required information-sheet headings. In order to scan the model standards quickly, the teacher should refer to the related table of contents for the standards.

Instruction Sheet Item No. 1

The first item on each of the student instruction sheets described here is "Model Standard No., Title, and Statement." The model standard number and title may be taken from the standards menu (table of contents, appropriate cluster) or from the correct standard heading within the standards text itself. The wording of the introductory statement that follows the title of the model standard may be copied directly onto the student instruction sheet.

Instruction Sheet Item No. 2

Item number 2 on each of the described student instruction sheets is "Objective/Competency Statement." The objective/competency statement is derived from the model standard. The standard statement has been written to describe what the student will understand or be able to do upon achieving that standard. The standard statement is the basis for writing the objective/competency statement. Only the quality factor of this statement (how well the student must perform the tasks of the objective) must be written by the teacher. It is important to note that the objective/competency statement is the basis by which the teacher measures student achievement. This statement of performance is related to the lesson plan in that it may be an identical statement or subset statement to the performance objective/competency statement written in the lesson plan. This statement is also the basis for preparing the method of student evaluation. Prior to writing this statement, the teacher may want to refer to the discussion in Section Three relative to student performance, writing competency statements, and student evaluation.

Instruction Sheet Item No. 3

Item number 3 on each of the described student instruction sheets is "Introduction." The introduction part of each instruction sheet should clearly define how the effort expended in completing the sheet will benefit the student. The purpose of the introduction is to motivate the student, stimulate the student's interest in performing the work involved in completing the sheet, and explain the instructional sheet's practical application and the tie-in with previously learned skills or knowledge. References or linkages to future learning topics are also important. The teacher should use this section of the instructional sheet to inform the student of the value of the subject matter, but should keep this section short—one or two paragraphs at most.

Instruction Sheet Item: Test Questions

Found often as item number 5 or number 6 on the described student instruction sheets, test questions are an important way to assess the student's mastery of the topic; they can also be used as a method of instruction. An important part of student learning can occur during a class review of test questions. In developing instruction-sheet questions, the teacher should consider questions from the perspective of both the teacher's delivery of the subject and the student's learning.

A properly framed question represents a balance between clarity and detail. Questions must be clear and concise. Test questions from the instruction sheets can be converted into true-or-false or multiple-choice questions and used on quarter or final examinations. The teacher should construct questions that test the student's knowledge of critical or significant parts of the course. Questions that are not germane to the topic make it difficult to motivate the student for the next lesson.

Essay-type questions used on instruction sheets are also a good means of linking academic writing skills to the industrial and technology education core curriculum. Therefore, the teacher should check the student's sentence structure, grammar, and spelling.

Each of the six student instruction sheets has a special purpose. Therefore, in addition to the items just discussed, each of the instruction sheets will have specialized sections designed to achieve a specific purpose. These sections are described in this guide in a detailed statement that precedes the specific instruction sheet.

Instruction Sheet Considerations

Instruction sheets are management tools. When the teacher records the student's completion of each instruction sheet, it becomes documentation to show the student's progress toward achieving the stated course competencies. These sheets can provide students with a preview of the next topic, act as a student guide to the current topic, or serve as a review of the previous topic. It is recommended that each student have a three-ring binder and that each instruction sheet be three-hole punched to be kept in the binder; this will help preserve the sheets for the student's further reference and better enable the teacher to check the student's progress.

Instruction sheets can also be used in conjunction with a teacher aide. If the teacher aide is well-versed in the content of the instruction sheet, the aide can assist the student in achieving learning goals. The student instruction sheet helps both the teacher and the student in the transition from subject presentation to the application step, and it helps the student achieve mastery of each instructional topic. Instruction sheets facilitate individual instruction, permitting students to progress in accordance with their own capabilities. They also enable the teacher to introduce the next topic to one group of students while still working with others to complete a current or previous assignment. Instruction sheets can also be an aid to the substitute teacher when the regular teacher is absent.

Instruction sheets facilitate the implementation of the teacher's lesson plan. They are student action-oriented, and they are identified in the student application/learning activity section of the model lesson plan (Section One of this document).

Assignment Sheet (Form H)

The assignment sheet (Form H) is prepared by the teacher as a student self-study guide. It guides students in completing a specific reading assignment. The assignment sheet is usually a single page containing all instructions, motivation, and study questions needed for the student to complete the assignment. The assignment sheet serves three purposes:

1. To provide the student with a personal copy of the specific assignment to be read and understood
2. To motivate students, through the completion of the assignment, to develop self-discipline
3. To provide a means for student self-assessment in order that the student may gauge his or her learning progress

The sample assignment sheet provided is for teachers to use directly or to serve as a guide for one they may want to develop. An examination of the sample assignment sheet will show that it is composed of a number of headings and write-in spaces. Some of these spaces are for the teacher to complete, with the student completing the balance. The identification information is self-explanatory. (When preparing the sheet, the teacher fills in the spaces, with the teacher's name, the name of the course, and the title of the sheet.) Students can complete the rest of the information (assignment date, due date, student's name, and class period).

Assignment Sheet Item No. 4

The assignment sheet is typically used as a study aid for a specific reading assignment, and item number four, "Assignment," is a teacher-selected reading assignment appropriate to the topic identified from the four-step lesson plan.

Assignment Sheet Item No. 5

"References and/or Materials Needed" in a reading assignment may refer to more than one textbook, reference book, or other document the student is to read. All student readings are to be identified, using proper bibliography form (name of publication, author, date of publication, page numbers). This information tells the student exactly what is to be read.

Information Sheet (Form I)

The information sheet (Form I) is used when the information needed by the student is not readily available. Often the required information is located in one-of-a-kind reference books, technical manuals, or other documents. In such cases the teacher can summarize all germane information in an information sheet.

The information sheet serves two purposes:

1. It presents to the student a body of knowledge not readily available elsewhere.
2. It contains provisions (test questions) permitting students to test themselves.

Information sheets provided here as examples include a Form I and a continuation sheet for Form I. Form I, subtitled "Cover Sheet to Technical Information," directs the student through a reading and research activity. The teacher may design Form I in various formats to meet the needs of varying student ability levels, using the same technical information resources in all cases.

The continuation sheet for Form I is the actual "technical information" sheet. It includes a title identifying the technical information and a reproduction of the technical information. More than one continuation sheet may be needed.

A good information sheet is much like a good technical article—it tells, and it shows. Information sheets should be kept brief (no more than five pages) and concise. Illustrations and diagrams should be used where they serve to bring home the concept or idea quickly. Product technical sheets or manuals are a good source of materials for an information sheet.

Procedure Sheet (Form J)

Written directions for performing a particular operation or procedure can guide students through the proper sequence of operations to a successful conclusion. A procedure sheet (also called a job sheet or an operation sheet) can be very helpful because it stresses key items that must be considered. Most importantly, the procedure sheet enhances safe work habits and saves instructional materials. It also reinforces the teacher explanation/demonstration given to the class.

The sample procedure sheet provided here has been prepared using a two-page format. The identifying information items on the procedure sheet may be completed by using the directions given for similarly titled items on previous information sheets.

Carefully written, step-by-step instructions on the second page of the procedure sheet are critical to the success of the learner. The teacher should use great care in preparing this page. Provisions can be made at critical steps for teacher approval before the student continues with the next process in the sequence. Steps that are to be observed by the teacher may be so identified on the procedure sheet.

Procedure Sheet Development Tips

The procedure sheet is a teacher-designed instruction sheet that lists all the steps necessary to complete a work assignment. There will be times when a particular step may require some further explanation or precaution; these "key points" should follow their associated step on the instruction sheet.

A step is any action to be performed by the student to advance the assignment toward its completion; a key point is any information the student must know in order to carry out the action directed by the step. Identify each step on the procedure sheet by an Arabic number. Since steps involve action, they should be written as commands or orders. Each key point should be indented under its step and identified with a small letter in parentheses. Key points may include:

- Information about anything that may injure the student, damage equipment, or ruin materials
- Information about anything that can ensure that the procedure will be a success
- "Tricks of the trade" that make the step easier to perform
- Definitions of trade terms or technical words
- Information about correct use and care of tools, equipment, and materials
- Information about stock, supplies, or materials

Some steps will not require explanation or key points, whereas others may require a number of key points.

The procedure sheet is the one sheet among student instruction sheets that is designed to assist in teaching specific skills rather than related knowledge. Great care should be taken in developing these sheets so they will enhance teacher demonstrations. (See "The Demonstration Teaching Method" in Section Three of this guide.)

Media Guide (Form K)

Films, videocassettes, and other visual media support instruction. When properly incorporated, they may be used to do the following: (1) introduce a topic or problem; (2) stimulate student interest; (3) present a visual concept that cannot be presented to the class by any other method; (4) provide a summary or review at the end of a topic; (5) assist with an individualized learning experience; (6) provide a means of changing or developing student attitudes; and (7) provide an experience for building student appreciation of related occupations.

Media-Guide Keys

The Media Guide instruction sheet helps the teacher gauge the student's understanding of the content of the media presentation. Each student should be able to summarize several key points made in the presentation. Key points can be presented to the student as part of the teacher's introduction of the media presentation.

All media presentations used should be previewed by the teacher. During this preview session, critical points made in the presentation should be identified and listed. The key-point section of the media guide serves both as a means for the teacher to conduct an introduction to the media presentation and as a basis for summary discussion.

The media guide is an important element in the teacher's resource file. It can also be used by a substitute teacher, provided that arrangements to obtain the media presentation have been made prior to an absence.

Occupational Appreciation Sheet (Form L)

The purpose of the occupational appreciation sheet (Form L) is to guide the student in investigating an occupation associated with the instructional program.

This sheet introduces to the student certain concepts that may not have been covered in other instruction. The terms for where a person works and what the person does are introduced through the headings "Industry" (where the work is performed), "Job Title," and "Nature of Work" (what work is performed).

The single best resource to help the student complete the occupational appreciation sheet is the *Occupational Outlook Handbook*. It is published every two years by the U.S. Department of Labor and is available from the Superintendent of Documents. This publication can usually be found in your career center, public library, or ROP/C office.

Industry

"Industry" is the term economists use to describe a place where goods or services are exchanged for money. Students need to make a distinction between where one works and what one does; for instance, students in the robotics program may know about companies that use robotics, but they should also realize that government agencies also use robotics.

Employment Opportunities

The heading "Employment Opportunities" pertains to actual or current employment opportunities for the particular occupation under investigation. This information is often difficult to find, but students should spend some time in researching it.

The *Occupational Outlook Handbook* contains some information on current employment opportunities. Local offices of the California Employment Development Department have current information on local employment opportunities.

Job Outlook

This information is closely related to "Employment Opportunities," but it refers more to the future rather than to the present. Job outlook is important because it is an assessment of economic trends, potential developments, and other important factors affecting continued employment.

Additional Notes

The occupational appreciation sheet represents an important learning activity for the students, and it is particularly useful for a substitute teacher in the regular teacher's absence. The teacher can leave special instructions for the completion of the sheet, along with resources needed by the students, enabling a substitute teacher without technical background to help students complete the assignment.

Occupational appreciation sheets can also be developed for a number of other job-related topics not covered in regular instruction. Examples of such topics are history of the occupation, ethics, health conditions, personal hygiene, employer-employee relations, applicable laws, citizenship, working conditions, health and safety factors, and training programs.

Industry Tour Guide (Form M)

An industry tour can be an extremely important part of the instructional program. It is potentially an effective way to reinforce topics that have been presented. A good tour requires planning; there are logistical and legal requirements that must be met. (For this reason a section has been provided on the first page of the model industry tour guide instruction sheet for teachers to make clear how they expect the students to behave.) All requirements relating to industry tours by an educational institution must be observed.

No industry tour should be made unless there is a valid instructional reason for doing so. This reason should be no secret to the students. Before students visit a particular site, they should be thoroughly briefed as to what they are to observe and how they are to record their observations.

The industry tour guide sheet has space for the student to record the name of the firm and its principal activity: manufacturing, repair, retail sales, and so forth. Many of the larger firms are divided into departments such as shipping and receiving, inspection, painting and/or touch-up, assembly, and fabrication. Workers in these departments have specific job descriptions. The sample sheet is designed for the student to record observations made in visited departments. Other topics on the industry tour guide are as follows:

Jobs/Workers Observed

This topic heading is further divided into the following subheadings: "Job title"; Tools, materials, and processes performed"; and "Machinery used." These subtopics should help the student during interviews of employees.

Working Conditions

Sometimes a worker's surroundings are as important to job satisfaction as the actual tasks performed. It is important for the students to record their observations of the work environment.

Personal Interest

The "Personal interest" space was provided for the students to record some thoughts on what they saw that was of the most interest to them.

The industry tour guide sheet should be discussed with the students prior to the trip; each item on the sheet must be fully explained to them. The tour should be followed by class discussion. The guide can aid the teacher in conducting this "debriefing session" and in summarizing the experience.

It should be noted that good learning connections can be made between the guide sheet and the occupational appreciation sheet. Through the on-site visit to industry, the student can have the experience of seeing academic research made real.

Form H

Assignment Sheet

Lesson title ____________________ Teacher ____________________
Course title ____________________ Student ____________________
Block title ____________________ Prepared by ____________________
Unit title ____________________ Date ____________________
Cluster title ____________________ Due date ____________________

1. Model standard no. ____________ Title ____________________

   Statement:

2. Objective/competency statement:

3. Introduction:

4. Assignment:

5. References and/or materials needed:

6. Test questions:

Form I

Information Sheet

(Cover Sheet to Technical Information)

Lesson title ______________________ Teacher ______________________

Course title ______________________ Student ______________________

Block title ______________________ Prepared by ______________________

Unit title ______________________ Date ______________________

Cluster title ______________________ Due date ______________________

1. Model standard no. ______________ Title ______________________

   Statement:

2. Objective/competency statement:

3. Introduction:

4. References and/or materials needed:

5. Test questions:

Information Sheet
(Continued)

Student ______________________________

Sheet title ____

Form J

Procedure Sheet

(Student Activity Guide)

Lesson title ____________________ Student ____________________

Course title ____________________ Teacher ____________________

Block title ____________________ Period ____________________

Unit title ____________________ Assigned ____________________

Cluster title ____________________ Due date ____________________

1. Model standard no. ____________________ Title ____________________

   Statement:

2. Objective/competency statement:

3. Introduction:

4. References and/or materials needed:

5. Test questions:

Procedure Sheet
(Continued)

Student ______________________________

Step-by-step instructions:

Form K

Media Guide
(Study Guide for Media Presentations)

Lesson title ____________ Student ____________
Course title ____________ Teacher ____________
Block title ____________ Period ____________
Unit title ____________ Assigned ____________
Cluster title ____________ Due date ____________

1. Model standard no. ____________ Title ____________

   Statement:

2. Objective/competency statement:

3. Media title:

4. Introduction:

5. Key points observed in the media presentation:

6. Test questions:

Form L

Occupational Appreciation Sheet

(Student Occupational Exploration Guide)

Lesson title ____________________

Course title ____________________

Block title ____________________

Unit title ____________________

Cluster title ____________________

Student ____________________

Teacher ____________________

Period ____________________

Assigned ____________________

Due date ____________________

1. Model standard no. ____________ Title ____________________

   Statement:

2. Objective/competency statement:

3. Introduction:

4. References and/or materials needed:

5. Assignment:

Form L *(continued)*

Occupational Appreciation Sheet

(Continued)

Student ______________________

Occupational research record

1. Industry:

2. Job title:

3. Nature of work:

4. Working conditions:

5. Employment opportunities:

6. Advancement opportunities:

7. Job outlook:

8. Wages or salary:

3:4

Form M

Industry Tour Guide
(Student Record of Visits to Industry)

Lesson title ____________________ Student ____________________

Course title ____________________ Teacher ____________________

Block title ____________________ Period ____________________

Unit title ____________________ Assigned ____________________

Cluster title ____________________ Due date ____________________

1. Model standard no. ____________________ Title ____________________

   Statement:

2. Objective/competency statement:

3. Introduction:

4. Expected student behavior:

Industry Tour Guide
(Continued)

Student__________________________

Student observations

1. Name of industry:
2. Principal economic activity:
3. Departments visited:
4. Jobs/workers observed:
   a. Job title:
   b. Tools; materials; process performed:
   c. Machinery used:

   a. Job title:
   b. Tools; materials; process performed:
   c. Machinery used:
5. Working conditions:
6. Personal interest:

California Basic Educational Data System (CBEDS) Program and Course Codes

The program and course codes listed in this appendix can be used for a variety of purposes. However, the principal reason they were created was to provide a mechanism within the California Basic Educational Data System (CBEDS) to describe accurately the full scope of student, teacher, and administrator involvement in industrial and technology education. CBEDS is designed for an annual collection of data from school districts relating to staffing patterns and student enrollments. Its primary purpose is to satisfy a continuing need of the State Department of Education for information necessary for reporting, program management, and planning. CBEDS is designed to allow data to be combined in many ways to serve numerous purposes. It is also designed to reduce the number of information collection efforts conducted by the Department.

Because funding allocations and other important administrative and legislative decisions are made based on data collected through CBEDS, a working knowledge of this system is extremely important for industrial and technology education teachers and administrators. Responding to the annual CBEDS data collection is a critical activity; therefore, time spent in correctly selecting and recording the proper codes for the courses taught will eventually pay off in the federal funding of industrial and technology education programs.

Funding is not the only reason to select CBEDS codes correctly for courses and programs. The CBEDS codes and titles will be the mechanism for classifying the industrial and technology education curriculum to facilitate a statewide exchange network.

Industrial and Technology Education CBEDS Code Structure

The program and course-code information beginning on page 291 of this appendix is divided into two parts. The first part, under the heading "Cluster Composition Identification Codes (CBEDS Codes)," is a listing of the industrial and technology education cluster program/courses and the CBEDS codes and titles assigned to them. The remaining pages provide descriptions of the program/course titles to aid school district personnel in coding their industrial and technology education programs and courses.

Essentially, CBEDS is a course-coding scheme designed to collect course data. However, the arrangement of these codes by industrial and technology education clusters makes it possible for them to be used for both course and program identification. Before looking further into that concept, let us examine the structure of the codes.

Each industrial and technology education program cluster has been assigned a minimum of fifty possible code options. As you look down the codes you will note that gaps appear in the number sequence. These gaps allow for future expansion—for potential new programs or courses.

Continuing an examination of the code structure, note that apart from the Diversified Occupations cluster, six industrial and technology education specializations clusters have been arranged alphabetically. This is also the case for the subclusters within the Diversified Occupations cluster.

Essentially, industrial and technology education programs have been assigned a sequence of numbers beginning with 5501 and ending with 5999. This range of numbers permits a consistent coding structure in that the first two digits are the same throughout each cluster. For example, 55 has been assigned to the entire series of courses within the construction technology cluster.

Another consistency is that whenever courses that contain "Level I" or "Level II" in their titles are included within a cluster, they are always listed first within the cluster. All Level I courses have either 01 or 51 as the last two digits of their CBEDS code. Likewise, Level II courses have either 02 or 52 as their last two code digits.

Each of the titles that begins with the word "other" has been placed out of alphabetical sequence at the end of the cluster grouping. These titles have a CBEDS code that ends with either 49 or 99.

This numerically consistent code structure should enable the user to quickly find a specific code. For instance, construction technology teachers can simply remember that their code series ranges from 5501 to 5549; electronics technology teachers can remember that their code series ranges from 5551 through 5599; and so on. Along with remembering the appropriate numerical code series, the teacher should keep in mind that each course within a cluster is also listed in alphabetical order.

With the CBEDS codes structure well in mind, we can now consider the dual purpose of the coding system: it is to be used for both a course-coding system and a program-coding system.

Why a Coding System?

A coding system is needed to facilitate the classification, storage, retrieval, and analysis of information. In this era of computers and vast information storage, a coding system provides the most feasible means of locating and sorting information contained within a data base.

When one considers that at present more than 150 industrial and technology education program/course titles are offered in hundreds of elementary schools, middle schools, and high schools throughout the state, involving thousands of students and teachers, the reason for CBEDS becomes apparent. As efficient as CBEDS is, it is worthless if the data collected are not coded properly. Responding to October CBEDS data collection forms with the wrong codes marked on the data collection card will not help industrial and technology education, and ultimately this wrong information will harm the instructional program at the local level. To avoid this situation, the following information has been included to assist school personnel in understanding the CBEDS coding process.

The Program Concept

In Section One of this Process Guide, there is a brief discussion of the program concept. There the term "program" is described as a series of courses leading to a planned outcome. This definition suggests that if a student follows a specified series of courses, he or she will be prepared to enter the labor market in certain jobs, to go on to college, or to follow other post-high school plans. The key to using this definition, of course, is that at some point the series of courses related to specific post-high school plans must be specified. Since each school district offers differing programs and course combinations, the task of specifying programs and their related courses must be completed at the local level. In the following paragraphs a generic process for defining a program is described. For these purposes, industrial and technology education programs will use the CBEDS code structure.

Procedure for Program and Course Coding

By definition, a program is composed of a series of courses. This would suggest that these courses are offered in a definite sequence; that is, there is a prescribed order a student should follow to complete the program. This concept assumes that the subject matter contained in the entire program ranges from primarily exploratory or introductory to specific skill development. Therefore, a program is composed of a hierarchical arrangement of courses, with each course subordinate to the one above it.

Before we proceed with this discussion, an examination of the sample course sequence in Appendix B is perhaps in order. After looking at the program title, "Automotive Mechanics," and the related CBEDS code and title, look at the course sequence. Note that this example of a program/course sequence contains both academic and elective courses. A student following this sequence can graduate from high school and be prepared with the entry-level skills needed to enter the automotive trades. Note also that the proposed course sequence of industrial and technology education courses cuts across a number of the clusters, including Electronics Technology, Visual Communications Technology: Drafting, and Manufacturing Technology. Arranging courses in this manner shows graphically the contribution of subject matter in each course to the planned outcome of the program.

The sample program sequence also demonstrates the flexibility of the CBEDS coding structure to address changing technology. The introduction of at least one or possibly two courses in electronics within an automotive mechanics program is in response to the increasing use of microchips in automotive electrical systems.

Given the differences in course content and course availability within various school districts, it is not possible to provide specific directions for each program/course specification. However, certain general principles can be applied to accomplish this purpose.

The hierarchy of program design includes introductory, intermediate, and advanced courses. As in the example given in Appendix B, when specifying a program it is possible (and sometimes desirable) for one or more courses from different clusters to be assigned to the program (or to more than one program). In some instances, because of differences in the complexity of the total subject matter contained in the programs, the same course may be considered an intermediate course in one program and an advanced course in another.

Another principle in program planning is that one should always consider the total course sequence before selecting a program code. The program code should be assigned according to the highest or most complex course level to be included in the program.

Example: Specifying a Program Within the Construction Technology Cluster

To begin this example of the program course specification process, let us examine the descriptions given for each of the following:

5501 Construction Technology, Level I
5502 Construction Technology, Level II
5503 Apartment and Home Repair/Remodeling
5507 Carpentry
5531 Woodworking
5701 Drafting, Basic 1
5702 Drafting, Basic 2
5703 Architectural Drafting

For this example, assume that a school district is offering the above courses. The questions to be answered are:

What course sequence makes up the program?
Which code is to be used for the program?

This group of courses can be arranged into at least four separate programs—three within the Construction Technology cluster and one within the Visual Communications: Drafting cluster.

Besides the obvious program, 5502 Construction Technology, the other two programs in the Construction Technology cluster are: 5507 Carpentry and 5503 Apartment and Home Repair/Remodeling. The single program within the Visual Communications: Drafting cluster is 5703 Architectural Drafting.

For an illustration of how these courses may be arranged into one of these programs, examine the following course sequence:

5502 Construction Technology Program

First Year:
5531 Woodworking
5701 Drafting, Basic 1

Second Year:
5702 Drafting, Basic 2
5501 Construction Technology, Level I

Third Year:
5507 Carpentry
5703 Architectural Drafting

Fourth Year:

5502 Construction Technology, Level II

In this course sequence, the first two courses are introductory, one-semester courses. Although the two listed for the second year are year-long courses, they may still be considered introductory. The two courses offered during the third year are intermediate courses, designed to provide the student with essential basic skills and knowledge. The final course in the program series is the capstone, double-period course, designed to provide the student with the opportunity to master the advanced skills needed to successfully enter the construction industry.

Cluster Composition Identification Codes (CBEDS Codes)

Construction Technology

5501 Construction Technology, Level 1
5502 Construction Technology, Level 2
5503 Apartment and Home Repair/Remodeling
5504 Boat Building
5505 Brick, Block, and Stonemasonry
5506 Building Mechanical
5507 Carpentry
5508 Concrete Placing and Finishing
5509 Construction Equipment Operation
5510 Cooling and Refrigeration
5511 Drywall Installation
5512 Electrician
5513 Floor Covering Installation
5514 Furniture Making
5515 Glazing
5516 Heating and Air-Conditioning
5517 Insulation Installation
5518 Line Worker
5519 Locksmithing
5520 Millwork and Cabinetmaking
5521 Painting and Decorating
5522 Pipefitting and Steamfitting
5523 Plastering
5524 Plumbing
5525 Roofing
5526 Stage Technology, Level 1
5527 Stage Technology, Level 2
5528 Structural and Reinforcement Ironwork
5529 Tilesetting
5530 Upholstering
5531 Woodworking
5549 Other Construction Technology Courses

Electronics Technology

5551 Electronics Technology, Level 1
5502 Electronics Technology, Level 2

5553 Avionics
5554 Biomedical Equipment Technology
5555 Business Machine Repair
5556 Communications Electronics
5557 Computer Electronics
5558 Computer Service Technology
5559 Electromechanical
5560 Electronic Consumer Products Service
5561 Electronics Technology
5562 Hybrid Microelectronics
5563 Industrial Electronics
5564 Instrument Repair
5565 Instrumentation Technology
5566 Major Appliance Repair
5567 Motor Repair
5568 Small Appliance Repair
5599 Other Electronics Technology Courses

Manufacturing Technology

5601 Manufacturing/Materials Processing Technology, Level 1
5602 Manufacturing/Materials Processing Technology, Level 2
5603 CNC-Computer Numerical Control
5604 Foundry
5605 Industrial Ceramics Manufacturing
5606 Jewelry Design, Fabrication, and Repair
5607 Machine Tool Operation/Machine Shop
5608 Metal Fabrication
5609 Metallurgy
5610 Optical Goods Work
5611 Plastics/Composites
5612 Robotics
5613 Sheet Metal
5614 Tool and Die Making
5615 Welding: Brazing and Soldering
5616 Welding: Combination
5617 Welding: Electric
5618 Welding: Gas
5649 Other Manufacturing Technology Courses

Power, Energy, and Transportation Technology

5651 Introduction to Power, Energy, and Transportation
5652 Automotives
5653 Aircraft Mechanics
5654 Automotive Body Repair and Refinishing
5655 Automotive Mechanics
5656 Conventional Electric Power Generation
5657 Diesel Equipment Mechanics
5658 Heavy Equipment Maintenance and Repair
5659 Marine Power-Plant Maintenance
5660 Motorcycle Repair

5661 Small Engine Repair
5662 Truck and Bus Driving
5699 Other Power, Energy, and Transportation Courses

Visual Communications: Drafting

5701 Drafting, Basic 1
5702 Drafting, Basic 2
5703 Architectural Drafting
5704 Civil/Structural Drafting
5705 Computer-Aided Drafting
5706 Electrical/Electronic Drafting
5707 Mechanical Drafting
5708 Piping Drafting
5709 Technical Illustration
5749 Other Visual Communications, Drafting Courses

Visual Communications: Graphics

5751 Graphics, Level 1
5752 Graphics, Level 2
5753 Bookbinding
5754 Commercial Art
5755 Commercial Photography
5756 Composition, Make-Up, and Typesetting
5757 Desktop Publishing
5758 Photoengraving
5759 Photography, Lithography, and Platemaking
5760 Photographic Laboratory and Darkroom
5761 Printing-Press Operations
5762 Silk-Screen Making and Printing
5799 Other Visual Communications, Graphics Courses

Diversified Occupations

Personal Services:

5811 Barbering
5812 Cosmetology
5813 Electrolysis
5814 Manicuring and Pedicuring
5815 Massage
5819 Other Personal Services Courses

Fire Technology:

5831 Fire Control and Safety
5832 Fire Protection Administration
5833 Fire Fighting
5839 Other Fire Technology Courses

Law Enforcement/Security Services:

5841 Correctional Administration
5842 Corrections
5843 Criminal Justice Administration
5844 Criminal Justice Studies
5845 Criminal Justice Technology
5846 Forensic Studies
5847 Law Enforcement
5848 Law Enforcement Administration

5849 Security Services
5859 Other Law Enforcement/Security Services Courses
5861 Custodial Services
5862 Fabric Maintenance Services
5863 Leatherworking
5864 Textile Production and Fabrication
5869 Other Diversified Occupations Courses

Industrial Technology for Children

5900 Industrial Technology for Kindergarten
5901 Industrial Technology for First Grade
5902 Industrial Technology for Second Grade
5903 Industrial Technology for Third Grade
5904 Industrial Technology for Fourth Grade
5905 Industrial Technology for Fifth Grade
5906 Industrial Technology for Sixth Grade

Industrial Technology Explorations

5945 Communications Technology Exploration
5950 Construction Technology Exploration
5955 Manufacturing Technology Exploration
5960 Power, Energy, and Transportation Exploration
5965 Tools and Machines Exploration

Applied Technology

5975 Principles of Technology
5980 Applied Communications
5985 Applied Mathematics
5999 Department Chair: Industrial and Technology Education

Construction Technology

5500 Construction Technology: A group of instructional programs that prepares individuals to erect, install, maintain, and repair buildings, highways, airports, missile sites, and other structures, using materials such as metal, wood, stone, brick, glass, concrete, and composition substances. Instruction includes information on occupational opportunities, availability of advanced training, construction management safety, and instruction on job applications, resumes, job interviews, and promotions. The group includes instruction in cost estimating, fastening, and fitting various materials; in the use of hand and power tools; and in following technical specifications and blueprints.

5501 Construction Technology, Level 1: An instructional program that prepares individuals for enrollment in advanced vocational and technical education programs and includes occupational and basic technical information and laboratory experiences directly related to current practices in the construction industry. The purpose of the program is to assist individuals in making meaningful occupational and educational choices. Individuals are provided with information and basic skills in the erection, installation, maintenance, or repair of residential and industrial structures. Instructional activities are centered on building structures, using a variety of construction materials and processes, including design, masonry, carpentry, electricity, sheet metal, and plumbing.

5502 Construction Technology, Level 2: An instructional program that builds on the knowledge and skills learned in Construction Technology, Level 1, and includes advanced training in concepts and skills. Individuals are provided with information about and exposure to hand tools, power tools, portable power tools, mapping/surveying, level/transit, foundation/floors, masonry/concrete, insulation, glazing, building maintenance, landscape design, ditching/trenching, and pump and compressor operation.

5503 Apartment and Home Repair/Remodeling: An instructional program that provides individuals with the skills needed for making structural repairs on apartments and homes. Instruction includes hands-on training in carpentry, plumbing, electrical work, plastering, painting, and flooring. In addition, individuals are taught how to interpret construction blueprints and estimate costs of repairs and remodeling. A review of career opportunities and business management skills common to the building trades is included as part of the instruction.

5504 Boat Building: An instructional program that introduces individuals to the basics of line tables of offsets, lofting, and general techniques of building a boat from design drawings. The program provides the basic knowledge to evaluate building and repairing techniques required in boat building and repair. Individuals use hand tools and power tools to build or repair boats made of wood, fiberglass, ferrous metals, aluminum, or concrete.

5505 Brick, Block, and Stonemasonry: An instructional program that prepares individuals to lay bricks and blocks. The program includes instruction in laying out and spacing bonds; determining vertical and horizontal alignment of courses using gauges, plumb bobs, and levels; and cutting, notching, and shaping blocks, bricks, terra-cotta veneer, glass, and stone to construct or repair walls, partitions, arches, sewers, and fireplaces.

5506 Building Mechanical: An instructional program that prepares individuals to keep a building functioning and to service a variety of structures, including commercial and industrial buildings and mobile homes. The program includes instruction in the basic repair skills for maintenance of the air-conditioning, heating, plumbing, electrical, and other mechanical systems.

5507 Carpentry: An instructional program that prepares individuals to lay out, fabricate, erect, install, and repair wooden structures and fixtures, using hand and power tools. The program includes instruction in common systems of framing, in construction materials, in estimating, and in blueprint reading.

5508 Concrete Placing and Finishing: An instructional program that prepares individuals to construct forms; cut, erect, and fasten steel reinforcing bars and wire mesh; compact concrete by hand or with pneumatic vibrators; and finish exposed surfaces during hardening and after forms have been removed. The program includes instruction in the use of chemical additives and in hand and power concrete-handling equipment.

5509 Construction Equipment Operation: An instructional program that prepares individuals to operate and maintain a variety of heavy equipment, such as crawler tractors, motor graders and scrapers, shovels, draglines, hoes, and cranes. The program includes instruction in digging, ditching, sloping, stripping, grading, backfilling, clearing, and excavating.

5510 Cooling and Refrigeration: An instructional program that prepares individuals to install, operate, test, and service cooling and refrigeration systems. The program includes instruction in various types of systems, control devices, thermic units, and refrigerators.

5511 Drywall Installation: An instructional program that prepares individuals to install wallboard, plasterboard, or other interior surfaces in structures.

5512 Electrician: An instructional program that prepares individuals to install, operate, maintain, and repair electrically energized systems, such as residential, commercial, and industrial electric-power wiring, DC and AC motors, controls, and electrical-distribution panels. The program includes instruction in the use of test equipment.

5513 Floor Covering Installation: An instructional program that prepares individuals to test and repair subfloors and to install resilient tile, sheet goods, or carpeting. The program includes instruction in installing underlayments; cutting, fitting, and gluing lining; tacking, stapling, or taping padding; planning, laying out, fitting, and installing resilient flooring by gluing or loose-lay methods; installing cover-bases, self-coving, and carpet fasteners; trimming and seaming carpet; and installing stair treads, risers, and countertops.

5514 Furniture Making: An instructional program that prepares individuals to assemble and finish wood furniture. The program includes instruction in preparing freehand sketches; fastening wooden parts with glue; reinforcing joints with dowels, screws, staples, or nails, using power screwdrivers, staple guns, or hammers; and finishing or refinishing new, used, damaged, or worn furniture according to specifications.

5515 Glazing: An instructional program that prepares individuals to prepare, fit, and install glass in structural openings, such as windows, doors, and partitions, or in display cases and on table tops.

5516 Heating and Air-Conditioning: An instructional program that prepares individuals to install, operate, test, repair, and maintain commercial and domestic heating and air-conditioning systems.

5517 Insulation Installation: An instructional program that prepares individuals to install batt, blanket, board, loosefill, and other forms of insulation in residential, commercial, and industrial buildings in order to heat and cool interiors in energy-efficient ways.

5518 Line Worker: An instructional program that prepares individuals to repair, operate, and maintain local, long distance, and rural electrical lines; erect and construct pole and tower lines; and install underground lines.

5519 Locksmithing and Safe Repair: An instructional program that prepares individuals to repair and open locks, make keys, change lock and safe combinations, and install and repair safes.

5520 Millwork and Cabinetmaking: An instructional program that prepares individuals to engage in the mass production of such articles as window frames, moldings, trim, and panels and such products as store fixtures, kitchen cabinets, and office equipment. The program includes instruction in cutting, shaping, assembling, and refinishing articles; installing hinges, catches, drawer pulls, and other hardware; and planning and drafting layouts.

5521 Painting and Decorating: An instructional program that prepares individuals to finish exterior and interior surfaces by applying protective or decorative coating materials, such as paint, lacquer, and wallpaper. The program includes instruction in scraping, burning, or sanding surfaces; making and mixing paint; matching paint colors; applying coatings with brush, roller, or spray gun; and cutting, pasting, and hanging wallpaper.

5522 Pipefitting and Steamfitting: An instructional program that prepares individuals to lay out, fabricate, assemble, install, and maintain piping and piping systems, fixtures, and equipment for steam, hot water, heating, cooling, lubricating, sprinkling, and industrial processing systems based on a knowledge of systems operation and the study of building plans or working drawings.

5523 Plastering: An instructional program that prepares individuals to apply plaster, stucco, and similar materials to interior and exterior surfaces. The program includes instruction in lathing and in surface preparation, smoothing, and finishing.

5524 Plumbing: An instructional program that prepares individuals to assemble, install, and repair pipes, fittings, and fixtures of heating, water, and drainage systems according to specifications and plumbing codes.

5525 Roofing: An instructional program that prepares individuals to cover roofs and exterior walls of structures with waterproofing or insulating materials, such as asphalt, aluminum, slate, wood, and related composition materials.

5526 Stage Technology, Level 1: An instructional program that develops basic construction principles of stage property and scenery. Provides practice in stage crew work, including preparation of stage lighting and erection and striking of scenery. Introduces study of related technical and general information and provides an overview of related occupations in the theater, radio, and television.

5527 Stage Technology, Level 2: An instructional program that emphasizes the techniques and processes involved in stage management, construction, and lighting and the setup and operation of public address and projection equipment. This program stresses related technical and occupational information and provides increasingly complex technical activities. It includes the study of stage technology problems and offers activities consistent with individual interests and abilities.

5528 Structural and Reinforcement Ironwork: An instructional program that introduces individuals to reinforcing steel used in footings, foundations, walls, columns, poured beams, and bridges and in the infrastructures of private and commercial buildings. This program acquaints individuals with the use of steel in high-rise buildings. It includes instruction in the use of hand and power tools and in the processes and procedures used in the construction business.

5529 Tilesetting: An instructional program that prepares individuals to apply tile to walls, floors, ceilings, and roof decks. Includes instruction in fastening lath to walls; in spreading plaster and concrete; in leveling to the desired depth; in spreading mastic or adhesive base; and in cutting, shaping, and positioning tile.

5530 Upholstering: An instructional program that prepares individuals to engage in all aspects of the upholstering of furniture, automobile seats, caskets, mattresses, and bedsprings. The program includes instruction in installing, repairing, arranging, and securing springs, filler, padding, and covering material of mattresses and bedsprings; in cutting, sewing, and trimming; in cushion filling, tufting, and buttoning; and in wood refinishing.

5531 Woodworking: An instructional program that prepares individuals to lay out and shape stock; to assemble wooden articles or subassemblies; to mark, bind, saw, carve, and sand wooden products; to repair wooden articles; and to use a variety of hand and power tools.

5549 Other Construction Technology Courses: An instructional program/course in construction technology not described above.

Electronics Technology

5550 Electronics Technology: A group of instructional programs that prepares individuals for employment or advanced training in a variety of electronics industries. These programs prepare individuals to work with skilled technicians, paraprofessionals, engineers, and professionals performing research and design, manufacturing, maintenance, and service functions. Instruction includes theory, the underlying physical science and supporting mathematics, actual equipment, electronic and mechanical devices, test equipment, and analog and digital circuitry. Instruction prepares an individual to assemble, install, operate, maintain, and repair a variety of electronic equipment. Further training prepares individuals in the application, design, development, and testing of equipment and the preparation of written reports and test results.

5551 Electronics Technology, Level 1: An instructional program that prepares individuals for enrollment in advanced vocational and technical education programs and that includes occupational and basic technical information and laboratory experiences directly related to electricity and electronics. The purpose of the program is to assist individuals in making meaningful occupational and educational choices. Individuals are provided with the fundamentals of the theory, measurement, control, and applications of electrical energy. Instructional activities include reading instructions, interpreting schematics, setting up experimental apparatus, making measurements, testing circuits, and recording results.

5552 Electronics Technology, Level 2: An instructional course that prepares individuals for advanced electronics courses. This may be the first course in a series of courses that make up a program shown in the list following this course description. The course includes instruction in basic electronics theory, physical sciences and supporting mathematics, use of testing equipment, and power supplies. Instructional activities develop critical thinking skills, interpreting skills, and communication skills, and prepare individuals to diagnose malfunctions and determine alternatives.

5553 Avionics: An instructional program that prepares individuals to assemble, install, operate, maintain, and repair electronic equipment used in the aviation industry. Includes instruction in using various types of actual equipment, such as power supplies, receivers, radar systems, amplifiers, and digital and computer-controlled circuits.

5554 Biomedical Equipment Technology: An instructional program that prepares individuals to manufacture, install, calibrate, operate, and maintain the sophisticated life-support equipment found in hospitals, medical centers, and research laboratories. The program includes instruction in the use of testing and diagnostic instruments; in calibrating techniques; in potential hazards and safety precautions; and in methods of installation, repair, maintenance, and operation of the equipment.

5555 Business Machine Repair: An instructional program that prepares individuals to maintain and repair a variety of office machines, such as typewriters, dictation machines, calculators, data-processing equipment, duplicating machines, and mailing machines. The program includes instruction in diagnostic techniques, the use of testing equipment, and the principles of mechanics, electricity, and electronics as they relate to the repair of business machines.

5556 Communications Electronics: An instructional program that prepares individuals to assemble, install, operate, maintain, and repair one- and two-way communications equipment and systems, including AM and FM radio, television, hearing aids, and other electronic communication devices or systems. The program includes instruction in using actual equipment or educational trainers; in other types of equipment, including motors, mechanical devices, power supplies, amplifiers, and digital circuitry; in the use of testing equipment; and in Federal Communications Commission (FCC) licensing requirements.

5557 Computer Electronics: An instructional program that prepares individuals to assemble, install, operate, maintain, and repair computers and digital-control instruments. The program includes instruction in power supplies, number systems, gating logic, A-to-D and D-to-A converters, displays, timing circuitry, memory structure, address modes, buffers and registers, microprocessor design, peripheral equipment, programming, and interfacing, including the use of testing equipment and various computer electronic applications.

5558 Computer Service Technology: An instructional program that prepares individuals to install, program, operate, maintain, service, and diagnose operational problems in computer units or systems. The program includes instruction in the underlying physical sciences and supporting mathematics of computer design, installation, construction, programming, operation, maintenance, and functional diagnosis; and in how to detect, isolate, and correct malfunctions. Programs describe the electrical and electronic circuits and mechanical devices used in computer construction and their combination with systems in individual computers or computing installations. They also describe instruments used to detect weaknesses or failures in computer electrical systems.

5559 Electromechanical: An instructional program that prepares individuals to assist mechanical and electrical engineers and other managers in the design, development, and testing of electromechanical devices and systems, such as plant automation, automated control systems, servomechanisms, vending machines, elevator controls, tape-control machines, and auxiliary computer equipment. The program includes instruction in assisting with feasibility testing of engineering concepts; in systems analysis (including design, selection, testing, and application of engineering data); and in the preparation of written reports and test results.

5560 Electronic Consumer Products Service: An instructional program that prepares individuals to assemble, install, operate, maintain, and repair electronic equipment used at home and in businesses. The program includes instruction in power supplies, amplifiers, home entertainment systems, video cameras, home computers, security systems, radio and television receivers, cable TV systems, and other electronic applications.

5561 Electronics Technology: An instructional program that prepares individuals to support the electronics engineer and other professionals in the design, development, modification, and testing of electronic circuits, devices, and systems. The program includes instruction in practical circuit feasibility; prototype development and testing; systems analysis, including design, selection, installation, calibration, and testing; solid-state and microminiature circuits; and the application of engineering data to specific problems in the electronics field.

5562 Hybrid Microelectronics: An instructional program that prepares individuals to assemble, install, test, and repair hybrid microelectronic assemblies and subassemblies. The program includes instruction in bonding processes, the use of specialized equipment, and the use of special bench tools, hand tools, and other related equipment.

5563 Industrial Electronics: An instructional program that prepares individuals to assemble, install, operate, maintain, and repair electrical and electronic equipment used in industry and manufacturing. The program includes instruction in using equipment such as power supplies, amplifiers, motors, controls, digital and computer circuitry, synchro and servomechanisms, mechanical-power-transfer systems, hydraulic systems, and three-phase AC, electronic wave-shaping, and control circuitry.

5564 Instrument Repair: An instructional program that prepares individuals to maintain and repair various types of meters, measuring devices, and control devices, such as heating and air-conditioning controls; dial pressure gauges; scales and balances; electrical controlling, measuring, and recording devices; and optical, aeronautical, and navigational instruments. The program includes instruction in diagnosing malfunctions; in disassembling, repairing, and/or replacing faulty parts; and in cleaning, assembling, and adjusting instruments, using special bench tools, hand tools, and other meters and standards.

5565 Instrumentation Technology: An instructional program that prepares individuals to design and develop prototypes for testing, to evaluate control or measurement devices on systems, and to prepare graphs, written reports, and test results in support of professional personnel working in the field of instrumentation. The program includes instruction in the fields of electricity, electronics, mechanics, pneumatics, and hydraulics as they pertain to the principles of control, recording systems, automated devices, and the calibration of instrumentation units or systems.

5566 Major Appliance Repair: An instructional program that prepares individuals to repair, install, and service major gas, electric, and microwave consumer appliances, such as stoves, refrigerators, dryers, water heaters, washers, and dishwashers.

5567 Motor Repair: An instructional program that prepares individuals to assemble, install, test, maintain, and repair electric motors, generators, transformers, and related equipment.

5568 Small Appliance Repair: An instructional program that prepares individuals to repair, maintain, and service small appliances such as irons, toasters, waste-disposal units, vacuum cleaners, coffee makers, and dehumidifiers.

5599 Other Electronics Technology Courses: Instructional programs in electronics technology not described above.

Manufacturing Technology

5600 Manufacturing Technology: A group of instructional programs that prepares individuals in primary and secondary material processing. Primary processing systems change raw materials—metallic or polymeric—into standard industrial stock. Secondary material processing is organized around utility activities and processes, including casting and molding, forming, separating, conditioning, assembling, and finishing. The group includes instruction in the nature and application of management methods and techniques related to manufacturing.

5601 Manufacturing/Materials Processing Technology, Level 1: An instructional program that prepares individuals for enrollment in advanced vocational and technical education programs. The program includes operational and basic technical information and laboratory experiences directly related to the manufacturing processes used by industry. The purpose of the program is to assist individuals in making meaningful occupational and educational choices. Instructional activities focus on the study of the information and on the basic skills involved with industrial-technical materials and processes, including their properties and utilization as they are fabricated into usable products. Instructional activities involve hand and machine processes for the fabrication, analysis, or testing of metals, woods, and plastics.

5602 Manufacturing/Materials Processing Technology, Level 2: An instructional program that introduces individuals to production manufacturing processes. The program includes activities in the design, tooling, and assembling of industrial products. Emphasis is on the management and documentation of industrial enterprise systems.

5603 CNC—Computer Numerical Control: An instructional program that prepares individuals to program and operate computer numerically controlled machines. Study includes the evolution of a variety of numerically controlled machine tools and numerical control systems.

5604 Foundry Work: An instructional program that prepares individuals to engage in activities at ferrous and nonferrous foundries. Includes instruction in foundry equipment, various sands and refractories, sand and machine molding, coremaking, chipping, grinding, foundry chemistry, and metallurgy.

5605 Industrial Ceramics Manufacturing: An instructional program that prepares individuals to engage in manufacturing activities to produce ceramic machine tools, refractories for space vehicles, and brick, glass, crockery, tile, pipe, and other articles made from clays and silicas. The program includes instruction in testing physical, chemical, and heat-resisting properties of materials and in processing, forming, and firing clays to develop ceramic products.

5606 Jewelry Design, Fabrication, and Repair: An instructional program that prepares individuals to design, fabricate, and repair jewelry articles such as rings, brooches, pendants, bracelets, and lockets. The program includes instruction in model making, casting, engraving, polishing, and stone setting; in fitting rings, soldering broken parts, and reshaping and restyling old jewelry; and in using special jeweler's hand tools and machines.

5607 Machine Tool Operation/Machine Shop: An instructional program that prepares individuals to shape metal parts on machines such as lathes, grinders, drill presses, milling machines, and shapers. The program may also train individuals in the use of one machine tool. Included is instruction in computations related to work dimensions, in testing feeds and speeds of machines, and using precision measuring instruments such as layout tools, micrometers, and gauges; in machining and heat-treating various metals; and in laying out machine parts.

5608 Metal Fabrication: An instructional program that prepares individuals to fabricate and assemble a variety of products. It includes instruction in layout, sequence of design and construction of templates and fixtures, and the positioning, aligning, fitting, and welding of parts.

5609 Metallurgy: An instructional program that describes the chemical, physical, and mechanical properties of materials, including metallic materials, alloys, ceramics, and polymers. Instruction includes material selection, heat treatment, and mechanical testing.

5610 Optical Goods Work: An instructional program that prepares individuals to mold and cast optical products, patterns, and prototype parts such as eyeglass lenses and contact lenses.

5611 Plastics/Composites: An instructional program that prepares individuals to mold and cast plastic parts, patterns, and prototype parts; to fit, fabricate, and repair internal carvings; to finish plastic parts; and to assemble plastic components into products.

5612 Robotics: An instructional program that prepares individuals to assemble, program, maintain, and repair robotic devices. The program includes instruction in the history and development of robotic devices and the types of robotic devices used in industry and their component makeup. Instruction also includes computer control systems, robot computer language programming, and troubleshooting techniques. Instruction deals with servomechanisms, microprocessors, and computer operation and their integration into a total manufacturing system.

5613 Sheet Metal: An instructional program that prepares individuals to lay out, fabricate, erect or install, and maintain items made of steel, copper, stainless steel, and aluminum, using hand tools and machines such as cornice brakes, forming rolls, and squaring shears.

5614 Tool and Die Making: An instructional program that prepares individuals to analyze specifications, to lay out metal stock, and to set up and operate machine tools to fit and assemble parts for the manufacture and repair of metalworking dies, cutting tools, fixtures, gauges, and machinists' hand tools.The program includes instruction in metal properties and in the application and construction of tool and die design.

5615 Welding: Brazing and Soldering: An instructional program that prepares individuals to use gases and welding processes to braze and solder metallic parts and to plan and lay out materials as specified by blueprints or written specifications.

5616 Welding: Combination: An instructional program that prepares individuals to use metal arc (SMAW), gas metal arc (GMAW), gas tungsten arc (GTAW), and electrical welding equipment to weld metal parts and to plan and lay out materials as specified by diagrams, blueprints, or written specifications.

5617 Welding: Electric: An instructional program that prepares individuals to use gas welding and any combination of arc welding processes to weld metal parts and to plan and lay out materials as specified by diagrams, blueprints, or written specifications.

5618 Welding: Gas: An instructional program that prepares individuals to use gas welding and flame cutting equipment to weld or cut metal parts and to plan and lay out materials as specified by diagrams, blueprints, or written specifications.

5649 Other Manufacturing Technology Courses: Instructional programs or courses in manufacturing technology not described above.

Power, Energy, and Transportation Technology

5650 Power, Energy, and Transportation Technology: A group of instructional programs that prepares individuals to maintain and repair automobiles; aircraft; diesel engines in vehicles such as buses, ships, trucks, railroad locomotives, and construction equipment; stationary diesel engines in electrical generators; and small engines in mobile equipment such as lawnmowers and rotary tillers.

5651 Introduction to Power, Energy, and Transportation: An instructional program that prepares individuals for understanding the energy, power, and transportation industries and occupations by using exploratory experiences and laboratory activities. The purpose of the program is to assist individuals in making meaningful occupational and educational choices. Instructional activities focus on the theory, maintenance, and servicing of machines and devices, with emphasis on energy sources, small gas engines, basic electricity, and methods of transmitting power.

5652 Automotives: An instructional program that, as its primary purpose, prepares individuals to be better automobile owners and drivers. The program can also serve as the first phase for programs that ultimately prepare individuals for employment in automotive, truck, aircraft, and air-cooled gasoline-engine-powered equipment servicing and maintenance. Instruction includes, but is not limited to, the role of the automobile in the national and world economy; employment opportunities, working conditions, and training requirements in occupations related to the automobile; the principles of operation of basic automotive systems; and [illegible] basic service and maintenance of automotive systems.

5653 Aircraft Mechanics: An instructional program that prepares individuals to inspect, repair, service, and overhaul airplane parts, including engines, propellers, instruments, airframes, fuel and oil tanks, control cables, and hydraulic units. The program is designed to meet Federal Aviation Administration requirements for licensing as an airframe/power-plant mechanic.

5654 Automotive Body Repair and Refinishing: An instructional program that prepares individuals to repair automobile collision damage. Includes instruction in painting and finishing and body and frame alignment.

5655 Automotive Mechanics: An instructional program that prepares individuals to engage in the servicing and maintenance of all types of automobiles. The program includes instruction in the diagnosis of malfunctions in and repair of engines and of fuel, ignition, electrical, cooling, brake, drivetrain, and suspension systems. Instruction is also given in the adjustment and repair of individual components and systems such as radiators, transmissions, and carburetors.

5656 Conventional Electric Power Generation: An instructional program that prepares individuals to install, operate, and maintain electric power generating stations and to operate and maintain gas, oil, and coal furnaces, boilers, and electric generators; steam, gas, or hydroturbines; and diesel engines. The program includes instruction in special instrumentation, controls, and emergency and safety procedures.

5657 Diesel Equipment Mechanics: An instructional program that prepares individuals to repair diesel engines in vehicles such as buses, ships, trucks, railroad locomotives, and construction equipment and to repair stationary diesel engines in electrical generators and related equipment. The program includes instruction in diagnosing malfunctions; in disassembling engines and replacing parts; and in repairing and adjusting fuel-injection systems, oil and water pumps, generators, governors, auxiliary and accompanying power units, controls, and transmissions, using a variety of tools and testing and diagnostic equipment.

5658 Heavy Equipment Maintenance and Repair: An instructional program that prepares individuals to perform field maintenance of heavy equipment and general maintenance and overhaul of such equipment. The program includes instruction in the inspection, maintenance, and repair of tracks, wheels, brakes, operating controls, pneumatic and hydraulic systems, electrical circuitry, and engines and in the techniques of welding and brazing.

5659 Marine Power-Plant Maintenance: An instructional program that prepares individuals to repair outboard and inboard engines; to test, maintain, and repair steering devices and electrical systems; to repair metal, wood, and fiberglass; to fabricate and maintain sail; and to repair and balance propellers.

5660 Motorcycle Repair: An instructional program that prepares individuals to repair motorcycles and all-terrain vehicles (ATVs). The program includes instruction in the repair and servicing of all systems, including engines, transmissions, drivetrains, suspension, steering, frames, and wheels.

5661 Small Engine Repair: An instructional program that prepares individuals to maintain and repair small internal combustion engines used on portable power equipment such as lawnmowers, chain saws, rotary tillers, motorcycles, and snowmobiles.

5662 Truck and Bus Driving: An instructional program that prepares individuals to drive trucks and buses. The program includes instruction in operating gas, diesel, or electrically powered vehicles; loading and unloading cargo or passengers; reporting delays or accidents on the road; verifying loads against shipping papers; arranging transportation for personnel; and keeping records of receipts and fares.

5699 Other Power, Energy, and Transportation Courses: Instructional programs and courses in power, energy, and transportation technology not described above.

Visual Communications: Drafting

5700 Visual Communications, Drafting: A group of instruction programs that prepares individuals to plan, prepare, and interpret mechanical, architectural, structural, pneumatic, marine, electric/electronic, topographical, and other sketches; to use reproduction materials, equipment, and processes; to develop, plan, and process charts and drawings; to develop models; and to prepare reports and data sheets for writing specifications.

5701 Drafting, Basic 1: A survey instructional program that prepares individuals to plan, prepare, and interpret mechanical and machine, architectural, civil, structural, piping, electric and electronic, topographical, and other sketches; to use reproduction materials, equipment, and processes; and to develop, plan, and process drawings.

5702 Drafting, Basic 2: An instructional program that prepares individuals for enrollment in advanced vocational and technical education programs and that includes occupational and basic technical information and laboratory experiences directly related to drafting in industry. The purpose of the program is to assist individuals in making meaningful occupational and educational choices in the areas of mechanical and machine, architectural, civil and structural, piping, technical illustration, electrical and electronic, and topographical drawings. Instructional activities include lettering, freehand sketching, orthographic projection, geometric construction, computer-aided drafting, dimensioning, sectioning, reproduction, pictorial drawing, and auxiliary views, using technical drawing instruments and techniques.

5703 Architectural Drafting: An instructional program that prepares individuals to support architects and architectural engineers in developing plans for buildings or other structures, using a variety of building materials; to create layouts in keeping with building codes, zoning laws, ordinances, and other regulations; and to respect cost limitations and client preferences in styling and planning.

5704 Civil/Structural Drafting: An instructional program that prepares individuals to develop detailed construction drawings, topographical profiles, and related maps and specifications sheets for use in the planning and construction of highways, river and harbor improvements, flood-control structures, drainage structures, sanitation plants, and other structures. The program includes instruction in computing the volume of excavation and fill tonnage and in preparing graphs and hauling diagrams for use in earth-moving operations.

5705 Computer-Aided Drafting: An instructional program that prepares individuals to use a computer, computer software, and peripheral devices to create an image or drawing in the design and documentation of an object.

5706 Electrical/Electronic Drafting: An instructional program that prepares individuals to develop working drawings and wiring diagrams used by construction crews and repairmen to install and prepare electrical equipment, power plants, industrial establishments, and commercial or domestic buildings. The program includes instruction in drafting the wiring and schematic diagrams and in laying out drawings used to manufacture, assemble, install, and repair electrical and electronic equipment such as television cameras, radio transmitters, receivers, audio amplifiers, computers, and related equipment.

5707 Mechanical Drafting: An instructional program that prepares individuals to assist engineers in the development of detailed working drawings and related specifications for mechanical devices and machinery. The program includes instruction in sketching rough layouts; drafting detailed multiview drawings; and computing magnitude, direction, and point of application of tension, compression, and bending factors. Instruction also includes compiling and analyzing test data to determine design effects on machinery in relation to temperature, pressure, speed, horsepower, and fuel consumption; and producing drawings that indicate dimensions, tolerances, fasteners, joining requirements, and other engineering data.

5708 Piping Drafting: An industry-specific program that includes the techniques and knowledge necessary to construct drawings for the piping industry. These assembly drawings are necessary for power plants, pumping plants, heating systems, and plumbing systems.

5709 Technical Illustration: An instructional program that prepares individuals to present information graphically, including schematics, sections, exploded views, and other techniques that illustrate or clarify verbal or written description.

5749 Other Visual Communications, Drafting Courses: An instructional program/course in visual communications, drafting technology not described above.

Visual Communications: Graphics

5750 Visual Communications, Graphics: A group of instructional programs that prepares individuals to design and execute layouts and illustrations for advertising displays and instructional manuals. The program includes instruction in all phases of offset printing, layout, composition, presswork and binding, flexography, lithography, photoengraving, and other graphic arts related to the printing industry.

5751 Graphics, Level 1: An instructional program that prepares individuals for enrollment in advanced vocational and technical education programs by providing exploratory experiences and laboratory activities related to graphic arts. The purpose of the program is to assist individuals in making meaningful occupational and educational choices. The program focuses on the fundamentals of graphic arts, including the study of the printing industry. Instructional experiences include designing, composing, printing, and evaluating reproduction techniques.

5752 Graphics, Level 2: An instructional program that encompasses the skills acquired in Graphic Arts Level 1 and allows the student to extend those educational experiences to more complex areas. The student is allowed more extensive use of the equipment to enhance the application of those theoretical and limited practical skills acquired in Graphics Level 1.

5753 Bookbinding: An instructional program that prepares individuals to gather pages, forms, and related materials for assembly into books or pamphlets. Includes instruction in binding and repairing books and documents.

5754 Commercial Art: An instructional program that prepares individuals to design and execute layouts and to make illustrations for advertising displays and instructional manuals. The program includes instruction in the preparation of copy; lettering, poster, package, and product design; fashion illustration; silk screening; airbrushing; and ink and color dynamics.

5755 Commercial Photography: An instructional program that prepares individuals to use cameras and laboratory film-processing techniques. The program includes instruction in composition and color dynamics; contact printing; enlarging; developing film; use of air brushes, camera meters, and other photographic equipment; portrait, commercial, and industrial photography; processing microfilm; and preparing copy for printing or other graphic-arts processing.

5756 Composition, Make-up, and Typesetting: An instructional program that prepares individuals to lay out, compose, and make up typesetting and typecast, by hand and by machine.

5757 Desktop Publishing: An instructional program/course to provide supplemental educational experience to upgrade the student's level of experience in publications, using mini electromechanical equipment to enhance the quality of instant print and publications.

5758 Photoengraving: An instructional program that prepares individuals to photograph illustrations and other copy that cannot be set in type, to develop negatives, and to prepare photosensitized metal plates for use in printing.

5759 Photography, Lithography, and Platemaking: An instructional program that prepares individuals to work with lithography, lithographic photography, stripping, and related platemaking processes.

5760 Photographic Laboratory and Darkroom: An instructional program that prepares individuals to develop and print still or motion-picture film; to control resultant prints; to touch up negatives; and to finish, color, restore, and copy prints.

5761 Printing-Press Operations: An instructional program that prepares individuals to make ready, operate, and maintain printing processes.

5762 Silk-Screen Making and Printing: An instructional program that prepares individuals to make silk screens and to perform silk-screen printing operations.

5799 Other Visual Communications, Graphics Courses: An instructional program/course in visual communications, graphics technology not described above.

Diversified Occupations

5800 Diversified Occupations: A group of instructional programs not described in other cluster areas.

5810 Personal Services: A group of instructional programs that prepares individuals to render a variety of personal services.

5811 Barbering: An instructional program that prepares individuals to cut, shampoo, and style hair; and to shave, with special attention to hygiene, skin and scalp disease, and equipment sterilization. Instruction qualifies students for licensing examinations.

5812 Cosmetology: An instructional program that prepares individuals to care for and beautify hair, complexion, and hands by giving shampoos, rinses, and scalp treatments; by styling, setting, cutting, dyeing, tinting, permanent waving, and bleaching hair; and by giving facials, manicures, and hand and arm massages, with emphasis on hygiene, sanitation, customer relations, and salon management. Instruction qualifies students for licensing examinations.

5813 Electrolysis: An instructional program that prepares students to remove unwanted hair from the human body by means of an electric current applied to the body with a needle-shaped electrode.

5814 Manicuring and Pedicuring: An instructional program that prepares individuals to perform a manicure or pedicure.

5815 Massage: An instructional program that prepares individuals to administer systematic friction, stroking, slapping, kneading, or tapping to stimulate circulation, increase suppleness, promote healing, and induce relaxation in the human body.

5819 Other Personal Services Courses: An instructional program/course in personal services not described above.

5830 Fire Technology: A group of instructional programs that describe the theories, principles, and techniques of developing, administering, and managing services for fire prevention, fire fighting, and rescue.

5831 Fire Control and Safety: An instructional program that prepares individuals to function as fire control, prevention, and safety specialists. The program includes instruction in structural design and materials; meteorological factors impinging on fire situations; the chemistry of combustion; techniques for coping with fires; procedures for handling hazardous materials (such as petroleum products and other volatile, explosive, or corrosive materials), either routinely or in an accident situation; methods for inspection of equipment and its proper use; and methods for the inspection of public and private property for safety conditions.

5832 Fire Protection Administration: An instructional program that describes the theories, principles, and techniques of developing, administering, and managing services for fire prevention, fire fighting, and rescue.

5833 Fire Fighting: An instructional program that prepares individuals to fight fires and to control the outbreak of fire. The program includes instruction in fire department organization; the use of water and other materials in fire fighting; and various kinds of equipment, such as extinguishers, pumps, hoses, ropes, ladders, gas masks, hydrants, and standpipe and sprinkler systems. Methods of entry and rescue, salvage practices and equipment, and fire and arson inspection and investigation techniques are also included.

5839 Other Fire Technology Courses: An instructional program/course in fire technology not described above.

5840 Law Enforcement/Security Services: A group of instructional programs describing the principles and procedures for providing police, fire, and other safety services and for managing penal institutions.

5841 Correctional Administration: An instructional program that describes the theories and practices of structuring, managing, directing, and controlling agencies and organizations whose purpose is to provide safety and correctional services.

5842 Corrections: An instructional program that describes the theories, principles, and techniques of developing, administering, and managing for the incarceration, behavior modification, rehabilitation, and returning to society of legal offenders.

5843 Criminal Justice Administration: An instructional program that describes the theories and practices of structuring, managing, directing, and controlling criminal justice agencies, e.g., the various judicial and administrative court systems.

5844 Criminal Justice Studies: An instructional program that generally describes the principles and procedures of developing, administering, and managing correctional, law enforcement, and forensic services.

5845 Criminal Justice Technology: An instructional program that prepares individuals to work in a law enforcement agency, crime laboratory, mobile unit dealing with physical evidence, juvenile court, or correctional institution. The program includes instruction in patrol and investigative activities; traffic control; use of polygraph equipment; procedures for initial contact with the public in such matters as obtaining information, preparing reports, and testifying in court; techniques for collection, preparation, and transportation of physical evidence; methods of crime prevention; and methods for investigation and referral of neglected dependent children, delinquents, and youthful offenders.

5846 Forensic Studies: An instructional program that describes the theories, principles, and techniques of developing, administering, and managing services for relating and applying medical facts to legal problems.

5847 Law Enforcement: An instructional program that describes the theories, principles, and techniques of developing, administering, and managing services for the safety and protection of people and property.

5848 Law Enforcement Administration: An instructional program that describes the theories and practices of structuring, managing, directing, and controlling agencies whose purpose is to provide law enforcement.

5849 Security Services: An instructional program that prepares individuals to police private property to prevent thievery, malicious damage, and dishonesty among employees or patrons and to maintain order.

5859 Other Law Enforcement/Security Services Courses: An instructional program/course in law enforcement/security services not described above.

5860 Diversified Occupations: Instructional programs not described above.

5861 Custodial Services: An instructional program that prepares individuals to clean and care for buildings, fixtures, furnishings, floor surfaces such as linoleum, plastic, terrazzo, tile, rugs, and wood, and wall coverings such as panel, paint, plastic, wood, and synthetic materials. Instruction is given in using and caring for tools; in dusting, wet mopping, scrubbing, waxing, and refinishing surfaces; in cleaning toilets, windows, and walls; in applying various cleaning agents, protective coatings, and disinfectants; in scheduling work; and in purchasing custodial supplies.

5862 Fabric Maintenance Services: An instructional program that prepares individuals to operate and manage dry-cleaning and laundering plants. Includes instruction in receiving and inspecting garments; in identifying fabrics; in identifying spots and using cleaning agents; in washing and in dry and wet cleaning; in wrapping household furnishings, wearing apparel, and accessories; in making minor alterations and repair of articles; and in using a variety of hand and power tools and equipment.

5863 Leatherworking: An instructional program that prepares individuals to fabricate and repair all types of leather goods.

5864 Textile Production and Fabrication: An instructional program that prepares individuals for occupations involved with the entire spectrum of clothing, apparel, and textiles management, including but not limited to construction, fabric and fabric care, pattern design, principles in clothing construction and selection, fitting and alteration of ready-to-wear garments, custom tailoring, clothing maintenance, and textiles testing.

5869 Other Diversified Occupations Courses: Instructional programs and courses not described above.

Industrial Technology for Children

Industrial Technology for Children: Industrial technology education for children is designed to assist students in the attainment of the educational goals of the total elementary school program. It orients students to industrial technology, develops personal psychomotor skills, and refines attitudes about the influence of technology on society. These activities provide students with experiences that reinforce the elementary curriculum.

5900 Industrial Technology for Kindergarten: Industrial technology for kindergarten is designed to assist students in the attainment of the educational goals of the kindergarten program. It is designed to orient students to industrial technology and to help them develop personal psychomotor skills. This program provides experiences that reinforce the kindergarten curriculum and provides opportunities to learn fundamental concepts about how people create and control their environment. It also develops technological awareness and reinforces and enriches concepts in mathematics, the sciences, history–social science, and other subject areas.

5901 Industrial Technology for First Grade: Industrial technology for first grade is designed to assist students in the attainment of the educational goals of the first-grade program. It is designed to orient students to industrial technology and to help them develop personal psychomotor skills. This program provides experiences that reinforce the first grade curriculum and provides opportunities to learn fundamental concepts of how people create and control their environment. It also develops technological awareness and reinforces and enriches concepts in mathematics, the sciences, history–social science, and other subject areas.

5902 Industrial Technology for Second Grade: Industrial technology for second grade is designed to assist students in the attainment of the educational goals of the second grade program. It is designed to orient students to industrial technology and to help them develop personal psychomotor skills. This program provides experiences that reinforce the second grade curriculum and provides opportunities to learn fundamental concepts about how people create and control their environment. It also develops technological awareness and reinforces and enriches concepts in mathematics, the sciences, history–social science, and other subject areas.

5903 Industrial Technology for Third Grade: Industrial technology for third grade is designed to assist students in the attainment of the educational goals of the third-grade program. It is designed to orient pupils to industrial technology and to help them develop personal psychomotor skills. This program provides students with experiences that reinforce the third grade curriculum and provides opportunities for them to learn fundamental concepts about how people create and control their environment. It also develops technological awareness and reinforces and enriches concepts in mathematics, the sciences, history–social science, and other subject areas.

5904 Industrial Technology for Fourth Grade: Industrial technology for fourth grade is designed to assist students in the attainment of the educational goals of the fourth-grade program. It is designed to orient them to industrial technology and to help them develop personal psychomotor skills. This program provides students with experiences that reinforce the fourth grade curriculum and provides opportunities for them to learn fundamental concepts about how people create and control their environment. It also develops technological awareness and reinforces and enriches concepts in mathematics, the sciences, history–social science, and other subject areas.

5905 Industrial Technology for Fifth Grade: Industrial technology for fifth grade is designed to assist students in the attainment of the educational goals of the fifth-grade program. It is designed to orient students to industrial technology and to help them develop personal psychomotor skills. This program provides students with experiences that reinforce the fifth grade curriculum and provides opportunities for them to learn fundamental concepts about how people create and control their environment. It also develops technological awareness and reinforces and enriches concepts in mathematics, the sciences, history–social science, and other subject areas.

5906 Industrial Technology for Sixth Grade: Industrial technology for sixth grade is designed to assist students in the attainment of the educational goals of the sixth-grade program. It is designed to orient students to industrial technology and to help them develop personal psychomotor skills. This program provides students with experiences that reinforce the sixth grade curriculum and provides opportunities for them to learn fundamental concepts about how people create and control their environment. It also develops technological awareness and reinforces and enriches concepts in mathematics, the sciences, history–social science, and other subject areas.

Industrial Technology Education Explorations

5940 Industrial Technology Explorations: Industrial technology education explorations is a broad-based industrial technology education program providing the middle school student with an integrated, common education core. Its focus is on career guidance; power, energy, and transportation technology; construction technology; manufacturing technology; communications technology; and tools and machines. As a result of participation in industrial technology education explorations, the student will be able to make informed career/occupational (educational) decisions upon entering high school, based on the knowledge and skills acquired and according to his or her personal interests and aptitudes.

5945 Communications Technology Exploration: Communications technology courses explore the fundamentals of message design, production, and transmission. Included is occupational and consumer information related to this important part of our industrial and technological society. Learning experiences include electronic and verbal communication activities as well as drafting, photography, and reprographics.

5950 Construction Technology Exploration: Construction technology is the study of information and skills involved in construction processes, organizations, and occupations. The program includes the study of a variety of materials, tools, and processes used in the construction industry. It covers construction concepts and activities as well as management and production practices as they currently relate to the construction industry and to other technical areas.

5955 Manufacturing Technology Exploration: Manufacturing technology courses cover the study of information and skills involved in manufacturing processes, organizations, and occupations. The program includes the study of a variety of materials, tools, and processes used in the manufacturing industry. It further provides learning and leadership experiences that give students a current look at the important industrial technical concepts of today and tomorrow.

5960 Power, Energy, and Transportation Exploration: Power, energy, and transportation exploration is a broad-based exploratory program providing the middle school student with an exploratory experience in power, energy, and transportation technology. As a result of participation in this program, the student will be able to make informed career/occupational (educational) decisions upon entering high school, based on the knowledge and skills acquired and according to his or her personal interests and aptitudes. Students will research current and future trends and the environmental impact of this technology system.

5965 Tools and Machines Exploration: This is a broad-based exploratory program, providing the middle school student with an exploratory experience in tool and machine technology. As a result of participation in tool and machine technology explorations, the student will be able to make informed career/occupational (educational) decisions upon entering high school, based on the knowledge and skills acquired and according to his or her personal interests and aptitudes.

Applied Technology

5970 Applied Technology: Applied technology includes the core academic areas of mathematics, science, and communications and covers the interrelationships of technology systems, careers in these areas, and safety practices. Students are given an opportunity to develop leadership qualities through laboratory activities and student vocational organization activities.

5975 Principles of Technology: Principles of technology is designed for students planning technical careers. It includes fourteen units presented over two years. Each of the fourteen units deals with one principle as it applies in the four energy systems—mechanical, fluid, thermal, and electrical—that make up both simple and complex technological devices and equipment. The units also cover the mathematics needed to understand and apply the principles. Most often, the units—force, work, rate, resistance, energy, power, and force transformers—are presented in the first year of instruction. The second year of instruction covers momentum, waves and vibrations, energy converters, transducers, radiation, optical systems, and time constants. These second-year elements complete the program.

5980 Applied Communications: Applied communications is designed for students planning technical careers. It includes 15 modules emphasizing that the workplace requires a variety of communication skills that seldom occur in isolation. Each module includes a variety of reading, writing, speaking, listening, and problem-solving skills. Students will develop and use higher-level thinking and problem-solving skills while dealing with the life- and work-related situations presented.

5985 Applied Mathematics: Applied mathematics is designed for students planning technical careers. It includes 25 units emphasizing the application of mathematical principles in the context of work-related situations, both in problem-solving exercises and in hands-on mathematics activities.

Example of a Program (Sequence of Courses)

CBEDS Code: 5655

Cluster Title: Power, Energy, and Transportation Technology

Program Title: Automotive Mechanics

Program Description

The automotive mechanics instructional program prepares individuals to engage in the servicing and maintenance of all types of automobiles. The program includes instruction in the diagnosis of malfunctions in and the repair of engines and drivetrains and of fuel, ignition, electrical, cooling, brake, and suspension systems. Instruction is also given in the adjustment and repair of individual components and systems, such as radiators, transmissions, and carburetors.

Related Occupations

Automotive technician, tune-up mechanic, air-conditioning mechanic, brake technician, smog technician

Sample Sequence of Courses

Ninth Grade

English
World Civilizations
Mathematics
Science
Visual/Performing Arts
Power, Energy, and Transportation Technology
Drafting I
Physical Education

Tenth Grade

English
Driver Education
Economics
Mathematics
Biology
Auto Mechanics I

Eleventh Grade

English
History
General Science
Auto Mechanics II
Electronics

Twelfth Grade

English
Government and Family Life
Welding or Electronics II
ROP/C Auto Service Mechanics or Power, Energy and Transportation Technology

Suggested Community College Courses

Automotive Electrical Systems
Automotive Fuel Systems
Automotive Emissions
Engine Tune-up
Automotive Drivelines
Automotive Brake Service and Repair
Automotive Suspension Systems

Sample District Course Outline

Automotive Service

Course Description

The automotive service course is designed for students who are high school seniors. The training emphasis is on the diagnosis of malfunctions and on the adjustment and component replacement or repair of the following: brakes; ignition, charging, and starting systems; emission control systems; wheels and tires; cooling and exhaust systems; suspension and alignment; and lubrication. Prerequisite: Power, Energy, and Transportation Technology.

Course Goals

1. To prepare the student with the entry-level skills necessary in the automotive service industry.
2. To prepare the student with an understanding of career specializations in the automotive service industry.

Total Instructional Hours

340 hours

Topical Outline

1.0 Orientation to ROP/C and the automotive service industry
- 1.1 Course outline and objectives
- 1.2 Proficiency and grading standards
- 1.3 Attendance and other student regulations
- 1.4 Automotive service industry—structure and employment opportunities

2.0 Industry safety practice
- 2.1 Hand tools
- 2.2 Equipment
- 2.3 Vehicle lifting and movement
- 2.4 Fire prevention
- 2.5 Hazardous material
- 2.6 Protective clothing
- 2.7 Student conduct

3.0 Shop organization and management
- 3.1 Classroom maintenance
- 3.2 Lab area maintenance
- 3.3 Student lab management
- 3.4 Repair orders

4.0 Automotive components
- 4.1 Identification and function of major components
- 4.2 Subsystem identification

5.0 Lubrication, preventive maintenance, and safety inspection
- 5.1 Customer communication
- 5.2 Check points—vehicle on floor
- 5.3 Check points—vehicle on hoist
- 5.4 Lubricants

5.5 Lubrication techniques
5.6 Wheel bearing servicing and adjustment
5.7 Filters and oil change
5.8 Final checks and vehicle delivery

6.0 Brake service

6.1 Basic hydraulics
6.2 Hydraulic brake systems
6.3 Automotive brake system types
6.4 Brake servicing—disc and drum
6.5 Brake service equipment operation
6.6 Hydraulic system bleeding
6.7 Parking brake
6.8 Power brake unit servicing
6.9 Brake system troubleshooting

7.0 Wheel balance and tire repair

7.1 Principles of balance
7.2 Diagnosis for wheel balance
7.3 Static balancing
7.4 Dynamic balancing machines
7.5 Tire inspection
7.6 Dismounting and mounting tires
7.7 Tire repair techniques

8.0 Front-end alignment and service

8.1 Suspension component identification and function
8.2 Alignment fundamentals
8.3 Alignment diagnosis
8.4 Alignment procedures and equipment use
8.5 Suspension component replacement or servicing

9.0 Automotive engine support systems

9.1 Automotive engine operating fundamentals
9.2 Cooling system—inspection and servicing techniques
9.3 Exhaust system—inspection and servicing techniques
9.4 Fuel system fundamentals
9.5 Fuel system component service

10.0 Automotive electricity

10.1 Basic electricity
10.2 Storage battery fundamentals
10.3 Storage battery—testing and servicing
10.4 Automotive lighting systems—troubleshooting and servicing
10.5 Charging system component testing—removal and replacement
10.6 Starting system diagnosis—removal and replacement
10.7 Ignition system fundamentals
10.8 Basic ignition system component service

11.0 Automotive engine tune-up and emission control

11.1 Tune-up and emission control
11.2 Emission control—types of systems

11.3 Ignition, fuel, emission system diagnosis and servicing techniques
11.4 Troubleshooting

12.0 Employment search techniques

12.1 Preparation of resumes and applications
12.2 Job search
12.3 Interview techniques
12.4 Adjustment to job
12.5 Employer relations

13.0 Internship

Glossary

Cluster: A grouping of industrial and technology education programs by the commonality of their subject matter. Each program in the cluster has its own homogeneous subject content but is part of a larger content concept; for instance, the construction technology cluster includes such programs as carpentry, drywall installation, plumbing, and electricity.

Course: A sequence of instructional units that includes a body of facts, understandings, processes, skills, values, and appreciations that constitute the substance of a specific aspect of knowledge, activity, or experience. A course is offered for a prescribed length of time, such as a quarter, a semester, or a year. When the student successfully completes the course, he or she receives a prescribed number of units.

Course Outline (Course of Study): A course outline is usually a topical listing of all subject matter to be included in a course. However, for the purposes of the *Curriculum Process Guide* in this document, the course outline also contains other pertinent information, such as course title, course description, course goals and objectives, and instructional hours and grade levels. Used in this context, course outline may also be referred to as a course of study.

Curriculum: All objectives, content, and learning activities arranged in a sequence for a particular instructional area. An orderly arrangement of integrated subjects, activities, and specific education goals.

Framework: A basic structure. In education, a framework is an outline of the components that make up a broad program of instruction. The *Industrial and Technology Education Model Curriculum Standards and Program Framework* refers to the broad industrial and technology education program, which ranges in scope from kindergarten through university and is organized within four defined administrative levels.

Instructional Unit: All of the materials the teacher has assembled to teach a lesson. These include a course outline, lesson plan, and any appropriate student instruction sheets, such as assignment sheets, procedure sheets, and media sheets.

Lesson Plan: A prepared guide for the teacher to use while presenting a lesson. The lesson plan includes the documentation needed for teacher review and preparation, for legal purposes, and for curriculum exchange.

Program: An organized sequence of courses leading to a predetermined outcome.

Standard: A rule or basis for comparison. The standards contained in the *Industrial and Technology Education Model Curriculum Standards and Program Framework* are the criteria for the curricular sequence.

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