

Massachusetts Department of Elementary & Secondary Education

Office for Career/Vocational Technical Education



Vocational Technical Education Framework



Manufacturing, Engineering & Technology Services Occupational Cluster

Drafting (VDRAF)

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Commissioner's Letter



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Mitchell D. Chester, Ed.D.
Commissioner

July 2014

Dear Colleagues,

I am pleased to present to you the *Massachusetts Vocational Technical Education Frameworks*, adopted by the Department of Elementary and Secondary Education in June 2014. These frameworks, one for each of the 44 vocational technical programs, include standards in multiple strands representing all aspects of the industries that students in the vocational technical education program are preparing to enter.

The frameworks also include a crosswalk between the technical standards and relevant standards in Massachusetts Curriculum Frameworks to support effective integration of academic and technical content.

The comments and suggestions received during revision of the 2007 *Massachusetts Vocational Technical Education Frameworks* have strengthened these frameworks. We will continue to work with schools and districts to implement the 2014 *Massachusetts Vocational Technical Education Frameworks* over the next several years, and we encourage your comments.

I want to thank everyone who worked with us to create challenging learning standards for Massachusetts students. I am proud of the work that has been accomplished.

Sincerely,

Mitchell D. Chester, Ed.D.
Commissioner of Elementary and Secondary Education

Introduction

Overview & Organization and Key Changes

Overview

The Massachusetts Department of Elementary and Secondary Education understands the necessity of maintaining current Vocational Technical Education Frameworks which ensure career/vocational technical education students across the Commonwealth are taught the most rigorous standards aligned to the needs of business and industry.

With the advent of the Massachusetts Teaching & Learning System the Office for Career/Vocational Technical Education (CVTE) recognized the significance of including career/vocational technical education in the system and developed a comprehensive plan for including vocational technical education. The plan was designed in a Two Phase Process. Phase One included the revision of strands two, three, and six, of all of the Vocational Technical Education Frameworks. Phase Two consisted of three major components (projects) all equally crucial;

1. The revision of Strands One, Four, and Five to complete the revision of all six strands of the Vocational Technical Education Frameworks;
2. Statewide Professional Development on all revised strands, with training on strands two, three, and six delivered fall 2013, and training on strands one, four, and five delivered spring 2014;
3. The creation and development of additional Model Curriculum Unit (MCU) Teams.

The Office for Career/Vocational Technical Education Framework Team, with support from consultants, began Phase One in the 2012-2013 school year, to revise three of the six strands contained in all of the Vocational Technical Education (VTE) Frameworks. The state was organized into “Collaborative Partnerships” comprised of teams of project administrators, highly qualified subject matter educators, and business and industry partners, whose task was to revise Strand Two – Technical, Strand Three – Embedded Academics, and Strand Six – Technology Literacy. Each team met with a vocational advisory committee which included business and industry representatives and postsecondary education professionals, whose mission was to review and revise the team’s draft document during the revisionary process. Once strand two was revised, academic teachers (typically one English Language Arts teacher, one Mathematics teacher, and one Science teacher) worked with the technical subject matter teachers to develop a crosswalk between academic curricula standards and the technical standards, and provided examples of embedded academic content.

The Office for Career/Vocational Technical Education solicited statewide input from technical and academic teachers and administrators at the annual Massachusetts Association of Vocational Administrators (MAVA)/Massachusetts Vocational Association (MVA) - Connecting for Success Conference. Each framework team met with their content colleagues and reviewed the draft revisions and obtained valuable feedback. Additionally, all drafts were reviewed and revised by the Massachusetts Vocational Technical Teacher Testing Program, to ensure appropriate measurable language.

Project consultants designed a new template to ensure all framework teams entered new standards and additional resources in a consistent manner. The framework teams created an “Appendix” listing potential industry recognized credentials attainable by secondary students; lists of professional, student, and relevant government organizations; and useful resources and websites. ** It is important to note that although most Framework Teams provided information for the “Appendix”, not all teams did. Therefore, sub-headings within the “Appendix” without information have been deleted. Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education.*

The Office for Career/Vocational Technical Education facilitated a comprehensive vetting process throughout the Commonwealth. During the fall of 2012 districts throughout Massachusetts solicited feedback from each Vocational Program’s Advisory Committee members at the Fall Board meetings. Additionally, the Office for Career/Vocational Technical Education met with various licensing boards at the Massachusetts Division of Professional Licensure and provided the applicable draft framework to each board for review. All framework drafts were posted on the CVTE website for public comment. Comments and suggested revisions received were shared with each framework team for response and edits, as appropriate.

The Phase I Process was completed on an accelerated timetable and resulted in all Vocational Technical Education Frameworks; Strand Two and Strand Six, revised with current, rigorous, relevant standards. Strand Three has been redesigned into a crosswalk which directly correlates academic and technical standards. An appendix of useful material for technical teachers recommended by their peers was added to each framework.

Phase II of the Framework Revision Process consisted of three major projects;

1. The Strands One, Four & Five Project, to complete the revision of all six strands of the Vocational Technical Education Frameworks;
2. Statewide Professional Development on all revised strands, with training on strands two, three, and six delivered fall 2013, and training on strands one, four, and five delivered spring 2014;
3. The creation and development of additional Model Curriculum Unit (MCU) Teams.

The Strands One, Four, & Five Project began in the fall of 2013 with the formation of a leadership team and three work groups. Co-Managers led the leadership team comprised of three Strand Coordinators who facilitated work teams and reviewed, researched, and revised these common strands. All skills specific to the vocational technical program have been included into Strand Two Technical.

The Strand One Team revised the safety knowledge and skills that all students need to acquire. The team included relevant issues (i.e., bullying, climate), laws, regulations, guidelines and policies pertaining to safety.

The Strand Four Team revised the Employability Knowledge and Skills that all students need to acquire. Teams considered current research on career readiness, including the work of the College Career Readiness Task Force convened by the Department, changes in workplace, technological changes that impact how people perform their work (i.e., communications methods), and included standards that

emphasize the need for lifelong learning and adaptability given the multiple career changes over and an individual's working life. The team recommended this strand be renamed to: Career Readiness.

The Strand Five Team revised the Management & Entrepreneurship Knowledge and Skills that all students need to acquire. All business owners and employees must possess management and financial skills to be productive members of society. Skills included financial knowledge and basic business management skills.

All Strand One, Four and Five Project Teams worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Massachusetts Career and Technical Student Organizations to crosswalk standards to national Career & Technical Student Organizations Curricula, as applicable.

The Office for Career/Vocational Technical Education contracted the MAVA Consultant Team to work closely with the office to complete all of the work accomplished during Phase II of the Project.

A remarkable amount of work was accomplished through the efforts of hundreds of professionals who collaborated and diligently supported this work. The Office for Career/Vocational Technical Education is grateful for all the support received from the field, particularly all of the teachers (technical and academic), administrators, advisory committee members, business and industry representatives, the Division of Professional Licensure - boards, the Massachusetts Association of Vocational Administrators, the MAVA Consultants, and the Massachusetts Vocational Association, whose contributions were tremendous.

Special thanks to all staff in the Office for Career/Vocational Technical Education and the CVTE Framework Revision Team who provided guidance and numerous contributions during Phase One of the project.

Organization and Key Changes

This section contains the following:

- Highlights of Changes to the Vocational Technical Education Frameworks; which includes a summary of changes made to each strand.
- Organization of the Frameworks – Strand Two illustrates structure of topic headings, standards and objectives, and performance examples.

Highlights of Changes to the Vocational Technical Education Frameworks:

Strand One:

Safety and Health Knowledge and Skills have been revised to contain the safety standards that are common to all programs. The Strand One Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Career and Technical Student Organizations (CTSO) to crosswalk standards to national CTSO Curricula, as applicable.

- No objectives were deleted, only modified.
- Language and wording was clarified.
- Additions included a focus on maintaining a safe school and workplace in terms of creating a positive climate/environment.
- Student safety credential program has been revised.
- Safety attire has been revised.
- Emergency equipment and fire safety has been revised.
- Many new Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

Strand Two:

The Technical Standards Knowledge and Skills have been revised to reflect business and industry changes since the adoption of the 2007 Vocational Technical Education Frameworks (VTEF). There are additional changes to Strand Two below:

- The Technical Knowledge and Skills (Strand Two) section contains standards specific to the particular vocational program; suffix "a" (as common to all programs) and suffix "c" (as common within a cluster) have been removed.
- Each VTEF Strand Two begins with safety and health knowledge and skills specific to the particular vocational program.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

- Strand Two of the Frameworks for Animal Science, Environmental Science and Technology, and Horticulture, begin with core standards required for all participants in the programs, followed by a series of standards organized in concentrations. See the section below titled: “Organization of the Frameworks – Strand Two” for more information.
- An update to some of the vocational programs framework is the addition of advanced or supplemental standards which are noted in Strand Two by an asterisk (*). *These standards are not required, but are provided as suggestions that districts may choose to use to increase the depth of a particular topic, or add additional topics, particularly for advanced students or for those seniors who do not participate in cooperative education.* See the section below titled: “Organization of the Frameworks – Strand Two” for more information.

Strand Three:

Since the purpose of Strand Three was to correlate academic content that was *embedded* in the knowledge and skills necessary to perform certain technical skills, it was logical to highlight those connections through a crosswalk between the academic curriculum standards and the technical standards (Strand Two). The crosswalk directly correlates the English Language Arts (2011) and Mathematics (2011) Frameworks, incorporating the Common Core Standards and the Science and Technology/Engineering Frameworks. The crosswalk can be found in the appendix of each vocational framework. The crosswalk also includes performance examples which illustrate integrated academic and technical content.

- Embedded Academics has been replaced with a crosswalk between the academic curriculum standards and the technical knowledge and skills standards. The crosswalk is located in the Appendices.

Strand Four:

Employability (and Career Readiness) Knowledge and Skills focused on providing students with general knowledge and skills to be college and career ready. The Strand Four Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Career and Technical Student Organizations to crosswalk standards to national CTSO Curricula, as applicable.

- Language and wording were clarified.
- Additions included a focus on providing students with skills for employability/career readiness.
- Modifications included Career Exploration & Navigation, Communication in the Workplace, and Work Ethic & Professionalism.
- New Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: “Organization of the Frameworks – Strand Two”. All strands were organized in that manner, with the exception of the former Strand Three.

Strand Five:

Strand Five contains Management and Entrepreneurship Knowledge and Skills that are general for all students. The Strand Five Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Massachusetts Career and Technical Student Organizations to crosswalk standards to national Career & Technical Student Organizations Curricula, as applicable.

- Language and wording were clarified and organized into a logical format.
- The Strand Five Team felt that the 2007 curriculum remained valid.
- Additions included a focus on providing students with skills for management and entrepreneurship applicable to all vocational programs.
- Modifications included Starting and Managing a Business, Marketing, and Financial Concepts & Applications in Business, and Legal/Ethical/Social Responsibilities.
- New Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: “Organization of the Frameworks – Strand Two”. All strands were organized in that manner, with the exception of the former Strand Three.

Strand Six

Strand Six Technology Literacy Knowledge and Skills has been replaced with the 2008 Massachusetts Technology Literacy Standards and Expectations Framework.

Appendix¹

Each framework contains an “Appendix” section which includes an Embedded Academic Crosswalk, Industry Recognized Credentials, Statewide Articulation Agreements, Professional, Governmental, and Student Organizations, Resources, and relevant websites.

The Appendix² contains:

- Embedded Academic crosswalks for English Language Arts, Mathematics, and Science & Technology/Engineering.
- Statewide Articulations: Current statewide Articulation Agreements and/or Apprenticeship Programs available to the specific vocational program are listed on this page. The development of new statewide articulations continues, and therefore these pages will be revised as new agreements are finalized.
- Industry-Recognized Credentials: Technical Teacher Teams generated lists of credentials for the vocational programs. Program Advisory Committees throughout the state reviewed and provided recommendations through the validation process. *The credential list has been provided as a resource only and districts are not obligated to provide all of the specified credentials for students.*
- Other: These pages provide lists of reference materials, government agencies, professional and student organizations, and useful websites created by each framework team. These are intended as helpful resources for technical teachers, identified by peers. These are not recommended or required by the Department of Elementary & Secondary Education.

¹ Note: Although most Framework Teams provided information for the “Appendix”, not all teams did. Therefore, sub-headings within the “Appendix” without information have been deleted.

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Organization of the Frameworks – Strand Two

The Vocational Technical Education Frameworks contain knowledge and skills covering all aspects of industry, reflected in six strands: Safety and Health, Technical, Embedded Academics, Employability, Management and Entrepreneurship, and Technological.

Within each strand, standards and objectives were grouped under topic headings, which are displayed in bold. Each standard is followed by a performance example. In the excerpt below, 2.A is the topic; 2.A.01 is the first standard and 2.A.01.01 and 2.A.01.02 are the objectives under that standard.

2.A Automotive Technology Specific Safety Practices

- 2.A.01 Identify and describe safety procedures when dealing with different types of automotive lifts according to current industry standards.
- 2.A.01.01 Demonstrate procedures for safe lift operations.
 - 2.A.01.02 Demonstrate safe use, placement and storage of floor jacks and jack stands.

2.A.01 Performance Example:

- Student will set up lift using manufacturer’s suggested lift points.

- 2.A.02 Demonstrate and describe safety procedures when dealing with high pressure systems including necessary ventilation according to current industry standards.

- 2.A.02.01 Describe and demonstrate the importance of safety procedures to be used when servicing high pressurized systems (fuel systems, brakes, air conditioning, suspension, hydraulic systems, etc.).
- 2.A.02.02 Describe and demonstrate safe use of oxygen/acetylene torches and electric welding equipment.
- 2.A.02.03 Demonstrate ventilation procedures to be followed when working in the lab/shop area.

2.A.02 Performance Example:

- Student will relieve fuel system pressure to perform necessary repairs.

- 2.A.03 Identify and describe safety procedures when dealing with electrical circuits according to current industry standards.

- 2.A.03.01 Describe safety procedures to be followed when servicing supplemental restraint systems.
- 2.A.03.02 Demonstrate safety awareness of high voltage circuits of electric or hybrid electric vehicles and related safety precautions.

2.A.03 Performance Example:

- Safely disable Supplemental Restraint System (SRS) air bag for repair using manufacturer’s recommendations.

There are additional changes to some of the Frameworks Strand Two (Technical Knowledge and Skills). Specifically, Strand Two of the Frameworks for Animal Science, Environmental Science and Technology and Horticulture begin with core standards required for all participants in the programs, followed by a series of standards organized in concentrations. For example, Strand Two of the Horticulture Framework begins with the core standards required of all Horticulture students (Topics 2.A through 2.I). These standards are followed by the three concentrations: Arboriculture

(Topics 2.J through 2.L), Greenhouse Management and Floriculture (Topics 2.J. through 2.L) and Landscape and Turf Management (Topics 2.M through 2.Q).

Advanced / Supplemental Standards (Not Required)

Another variation that is new to the revised Strand Two Frameworks is the addition of advanced or supplemental standards which are noted with the use of an asterisk (*). *These standards are not required, but are provided as suggestions that districts may choose to use to increase the depth of a particular topic, or add additional topics, particularly for advanced students or for those seniors who do not participate in cooperative education.*

The following is an example from Automotive Technology, where entire topics were added:

Advanced Automotive Technology Technical Knowledge and Skills

Note: The following competencies are optional, supplementary competencies suitable for advanced students. These are not required.

2.CC Demonstrate appropriate engine repair techniques.

2.CC.01 Perform appropriate cylinder Head Repair.

2.CC.01.01* Diagnose, remove and replace cylinder head(s).

2.CC.01.02* Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition; determine necessary action.

The following is an example from the Strand Two Radio and Television Broadcasting Framework that shows the addition of an advanced objective, 2.B.04.08*:

2.B.04 Explain concepts fundamental to shooting in cinema and video.

- 2.B.04.01 Compare and contrast a single-camera and a multiple-camera production.
- 2.B.04.02 Explain the importance of shooting for the edit (i.e., match on action, sequencing, coverage).
- 2.B.04.03 Explain the importance of continuity.
- 2.B.04.04 Explain the 180° Rule line, and its application in various cinema scenarios.
- 2.B.04.05 Identify and establish a specific point-of-view when shooting from a script.
- 2.B.04.06 Analyze the methods in which specific shots can evoke emotion from an audience.
- 2.B.04.07 Define drop frame and non-drop frame code shooting and explain how to account for both when preparing for an edit.
- 2.B.04.08* Describe various cinematographic methods necessary when shooting scenes that incorporate post-production visual effect

2.B.04 Performance Examples:

- Students will list similarities and differences of single-camera and multiple-camera shoots.
- Students will describe multiple shooting considerations that are useful in streamlining the editing process.

Manufacturing, Engineering & Technology Services Occupational Cluster

Drafting Framework (VDRAF)

Strand 1: Safety and Health Knowledge and Skills

1.A Fundamentals of Health and Safety

- 1.A.01 Describe and apply health and safety regulations.
- 1.A.01.01 Identify, describe and apply health and safety regulations that apply to specific tasks and jobs. Students must complete a safety credential program, e.g., Occupational Safety and Health Administration 10, CareerSafe and ServSafe.
 - 1.A.01.02 Identify, describe and apply Environmental Protection Agency (EPA) and other environmental protection regulations that apply to specific tasks and jobs in the specific occupational area.
 - 1.A.01.03 Identify, describe and apply Right-To-Know (Hazard Communication Policy) and other communicative regulations that apply to specific tasks and jobs in the specific occupational area.
 - 1.A.01.04 Explain procedures for documenting and reporting hazards to appropriate authorities.
 - 1.A.01.05 Identify and describe potential consequences for non-compliance with appropriate health and safety regulations.
 - 1.A.01.06 Identify and list contact information for appropriate health and safety agencies and resources.

1. A.01 Performance Examples:

- List and define OSHA Health and Safety Regulations, EPA and other environmental protection regulations to occupational area.
- List and define Right-to-Know regulations and reporting of hazards and contact information for appropriate health and safety agencies.
- List the laws and rules of regulatory agencies governing sanitation and safety.
- Utilize OSHA as well as health and safety websites for purposes of research.

- 1.A.02 Demonstrate appropriate health and safety practices based on the specific occupational area.
- 1.A.02.01 Identify, describe and demonstrate the effective use of Safety Data Sheets (SDS).
 - 1.A.02.02 Read and interpret chemical, product and equipment labels to determine appropriate health and safety considerations.
 - 1.A.02.03 Identify, describe and demonstrate personal, shop and job site safety practices and procedures.
 - 1.A.02.04 Demonstrate safe dress and use of relevant safety gear, personal protective equipment (PPE) and ergonomics, e.g., wrist rests, adjustable workspaces, equipment, gloves, proper footwear, earplugs, eye protection and breathing apparatus.
 - 1.A.02.05 Demonstrate appropriate safe body mechanics, including appropriate lifting techniques and ergonomics.
 - 1.A.02.06 Locate emergency equipment, first aid kit, SDS information directories and emergency action/response plan/escape routes in your lab, shop and

classroom, including labels and signage that follow OSHA Hazard Communication Program (HAZCOM), eyewash stations, shower facilities, sinks, fire extinguishers, fire blankets, telephone, master power switches and emergency exits.

- 1.A.02.07 Demonstrate the safe use, storage, and maintenance of every piece of equipment in the lab, shop and classroom, e.g., the OSHA Lockout/Tagout Program (LOTO).
- 1.A.02.08 Describe safety practices and procedures to be followed when working with and around electricity, e.g., ground fault circuit interrupter (GFCI) and frayed wiring.
- 1.A.02.09 Handle, store, dispose of and recycle hazardous, flammable and combustible materials, according to EPA, OSHA and product specifications.
- 1.A.02.10 Demonstrate appropriate workspace cleaning, sanitation, disinfection and sterilization procedures required in specific occupational areas, e.g., Workplace Housekeeping OSHA Regulations.

1. A.02 Performance Examples:

- Identify, describe and demonstrate the use of SDS.
- List and demonstrate shop dress code, safety procedures and location of emergency equipment in labor classroom.
- Define and demonstrate safe storage and maintenance of equipment and proper disposal or recycling of hazardous, flammable and combustible materials.
- Identify, describe and demonstrate the Universal Precautions set of guidelines.

- 1.A.03 Demonstrate appropriate responses to situations that may threaten health and safety.
 - 1.A.03.01 Describe First Aid procedures for potential injuries and other health concerns in the specific occupational area.
 - 1.A.03.02 Describe the importance of emergency preparedness and an emergency action/response plan.
 - 1.A.03.03 Describe procedures used to handle emergency situations, defensive measures and accidents, including identification, reporting, response, evacuation plans and follow-up procedures.
 - 1.A.03.04 Identify, describe and demonstrate safety practices in specific occupational areas used to avoid accidents.
 - 1.A.03.05 Identify and describe fire protection, protection, precautions and response procedures.
 - 1.A.03.06 Discuss the role of the individual and the company/organization in ensuring workplace safety including transportation to and from school, school activities and the workplace.
 - 1.A.03.07 Discuss ways to identify, prevent and report school and workplace violence, discrimination, harassment and bullying.
 - 1.A.03.08 Demonstrate positive and appropriate behavior that contributes to a safe and healthy environment in school and the workplace.

1. A.03 Performance Example:

- Define first aid procedures and protocols used to handle emergency situations and practices used to avoid accidents.
- View safety videos and discuss the role of workplace safety.
- Attend or participate in a human rights alliance organization presentation.
- Observe and/or demonstrate the appropriate use of a fire extinguisher using the (PASS) technique: Pull, Aim, Squeeze, Sweep.
- Review and discuss specific policies, procedures and protocols regarding discrimination, harassment and bullying.
- Discuss and/or role-play proper and respectful behavior that contributes to a positive climate.
- Discuss and/or demonstrate behavior that contributes to a collaborative/teamwork environment.

Selected Websites

- Bullying Prevention and Intervention Resources : www.doe.mass.edu/bullying
- Centers for Disease Control and Prevention: www.cdc.gov
- Environmental Protection Agency : www.epa.gov
- “Lost Youth – Four Stories of Injured Young Workers” – WorkSafeBC:
<http://www2.worksafebc.com/Publications/Multimedia/Videos.asp?reportid=34291>
- Massachusetts Department of Elementary and Secondary Education. (2011). Career/Vocational Technical Education Safety Guide: www.doe.mass.edu/cte
- Massachusetts Department of Elementary and Secondary Education: www.doe.mass.edu
- Massachusetts Emergency Management Agency: www.mass.gov/eopss/agencies/mema
- Massachusetts General Law: www.malegislature.gov
- Massachusetts Health and Human Services: www.mass.gov/dph
- Massachusetts Right to Know Law Summary:
<http://www.mass.gov/lwd/docs/dos/mwshp/hib397.pdf>
- Safety Data Sheet: www.sdsonline.com
- National Fire Protection Association: www.nfpa.org
- Protection of Student Rights: Massachusetts General Law:
<https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXII/Chapter76/Section5>
- Occupational Safety and Health Administration: www.osha.gov
- Readiness and Emergency Management for Schools: www.rems.ed.gov
- Safe and Healthy Learning Environments: www.doe.mass.edu/ssce/safety.html

Strand 2: Technical Knowledge and Skills

2.A Drafting Safety Knowledge and Skills

- 2.A.01 Demonstrate an understanding of the importance of wearing safety glasses in setting where hazards are present and on outside job sites.
- 2.A.02 Identify and apply good ergonomic practices as they apply to the work of Drafters, both in shop settings and on outside projects.

2.B Fundamental of Drafting and Design

- 2.B.01 Apply general drafting standards.
 - 2.B.01.01 Identify drawing media and related drafting materials.
 - 2.B.01.02 Annotate a drawing by using basic systems of measurement.
 - 2.B.01.03 Convert between English and metric systems (ISO) of measurement.
 - 2.B.01.04 Identify the alphabet of lines.
 - 2.B.01.05 Prepare title blocks and other drafting formats.
 - 2.B.01.06 Catalog and use number system for documentation and file management.
 - 2.B.01.07 Demonstrate methods used to record revisions.
 - 2.B.01.08 Produce prints, plots and reproductions to appropriate scale.

2.B.01 Performance Example:

- Create a drawing using appropriate format and size. Include proper linetypes, revision, notes, etc. Produce a print to appropriate scale.

2.B.02 Develop views.

- 2.B.02.01 Create orthographic views.
- 2.B.02.02 Create auxiliary views.
- 2.B.02.03 Create section views.
- 2.B.02.04 Create detail views.
- 2.B.02.05 Create isometric views.
- 2.B.02.06 Place views considering first and third angle projection.
- 2.B.02.07 Identify 1, 2, and 3 point perspectives.

2.B.02 Performance Example:

- Given an object, develop a drawing that requires the use of each of the views listed.

2.B.03 Apply the design process.

- 2.B.03.01 Evaluate a problem and develop a solution using the design process.
- 2.B.03.02 Interpret detail prints or technical processes.
- 2.B.03.03 Identify key elements that impact design.

2.B.03 Performance Example:

- Given a product, apply the design process to develop new or revised product. Include documentation for each step of process.

2.C Conventional Drafting Techniques and Skills

- 2.C.01 Create free-hand technical sketches.
 - 2.C.01.01 Letter using block style.
 - 2.C.01.02 Sketch basic concept and/or object proportionately.
 - 2.C.01.03 Make a sketch including detailed measurements/annotations.
 - 2.C.01.04 Sketch a basic object based on “customer” needs.

2.C.01 Performance Example:

- Given an object, sketch appropriate views in proportion with annotations.

- 2.C.02 Apply dimensioning.
 - 2.C.02.01 Apply correct dimension line terminators.
 - 2.C.02.02 Apply size and location dimension practices.
 - 2.C.02.03 Apply the use of dimensioning types (ordinate, leader, baseline/datum, chain, tabular).
 - 2.C.02.04 Identify appropriate standard symbols.
 - 2.C.02.05 Apply aligned and unidirectional methods.
 - 2.C.02.06 Apply general notes and/or annotations to a drawing.

- 2.C.02 Performance Example:
 - Using an existing drawing, apply appropriate dimensioning standards.

- 2.C.03 Measure, using the tools, knowledge and skills essential to drafting professionals.
 - 2.C.03.01 Identify different measurement tools and their applications.
 - 2.C.03.02 Measure parts using engineering, architectural, civil engineering, fractional, metric, and decimal inch scales.
 - 2.C.03.03 Measure parts using vernier caliper and micrometer.
 - 2.C.03.04 Develop drawings utilizing measurements.

- 2.C.03 Performance Example:
 - Create an as-built drawing based on actual measurements taken.

2.D Computer Aided Drafting and Design

- 2.D.01 Create CAD template.
 - 2.D.01.01 Set up layers/levels.
 - 2.D.01.02 Set up dimension types (units/precision/scale/style/etc.).

- 2.D.01 Performance Example:
 - Set parameters for a new drawing based on project requirements.

- 2.D.02 Produce CAD drawing.
 - 2.D.02.01 Edit CAD drawing.
 - 2.D.02.02 Manipulate CAD drawing.
 - 2.D.02.03 Extract CAD data (mass/volume/area/etc.).
 - 2.D.02.04 Create 3D models.
 - 2.D.02.05 Create translatable files (pdf, dxf, stl, iges, step, etc.).

- 2.D.02 Performance Example:
 - Modify or create model based on requirements, record CAD data and create output file.

2.E Mechanical Drafting and Design

- 2.E.01 Develop sheet metal patterns.
 - 2.E.01.01 Identify sheet metal terminology and gauges.
 - 2.E.01.02 Develop basic shapes using radial line and parallel line development.
 - 2.E.01.03 Develop a flat pattern for precision bending.

- 2.E.01 Performance Example:
 - Using a discarded product such as a milk carton or shoe box, create a full size pattern drawing.

- 2.E.02 Detail and Dimension Weldment.
 - 2.E.02.01 Identify welding processes.
 - 2.E.02.02 Identify various types of welded joints.
 - 2.E.02.03 Apply welding symbols to a drawing.

- 2.E.02 Performance Example:
 - Convert a cast part to a weldment using various symbols and processes.

- 2.E.03 Identify manufacturing processes.
2.E.03.01 Identify casting, forging, molding, extruding, machining, metal fabrication, and welding, etc. procedures.

2.E.03 Performance Example:
▪ Students create a presentation and assessment questions on one or more processes.

- 2.E.04 Produce mechanical drawings.
2.E.04.01 Draw detail drawings.
2.E.04.02 Draw assembly drawings.
2.E.04.03 Draw layout drawings.
2.E.04.04 Incorporate appropriate specification details using resources (standard/purchased items, machinery's handbooks, ASTM and ANSI standards, etc.).
2.E.04.05 Apply dual dimensioning for product and/or manufacturing drafting needs.

2.E.04 Performance Example:
▪ Create a layout, detail and assembly drawing for a simple product (pen, depth gauge, etc.)

- 2.E.05 Apply tolerances.
2.E.05.01 Identify tolerancing terminology.
2.E.05.02 Dimension with a consideration for tolerance stack-ups.
2.E.05.03 Calculate clearance and interference fit tolerance of mating parts using tables (RC, LN, FN, LT, LC).
2.E.05.04 Apply tolerance to dimensions using unilateral, bilateral and limits.
2.E.05.05 Apply geometric tolerance symbols.
2.E.05.06 Determine location of datum symbols.
2.E.05.07 Identify and apply surface (finish) control to part surfaces.

2.E.05 Performance Example:
▪ Create detail and assembly drawing with consideration of mating part fit.

- 2.E.06 Differentiate mechanical components.
2.E.06.01 Identify breaks, joints, couplings, bearings, clutches, belts, chains, gears, cams, etc.
2.E.06.02 Identify different types of fasteners (e.g., screws, nuts, rivets, springs, keys, pins, washers, etc.).
2.E.06.03 Specify thread nomenclature, series, classifications, and fits and forms.

2.E.06 Performance Example:
▪ Students create a presentation and assessment questions on one or more components.

- 2.E.07 Identify electro-mechanical drawings.
2.E.07.01 Identify basic electric/electronic components and symbols used in drafting.
2.E.07.02 Identify a schematic, wiring diagram, circuit diagram, and cable/harness drawings.

2.E.07 Performance Example:
▪ Interpret an existing diagram identifying appropriate symbols.

2.F Architectural Drafting and Design

- 2.F.01 Identify building types.
2.F.01.01 Distinguish between commercial, residential, and industrial construction.

2.F.01.02 Recognize the architectural styles of buildings.

2.F.01 Performance Example:

- Students create a presentation and assessment questions on building types and styles.

2.F.02 Draw construction drawings.

2.F.02.01 Select appropriate references (building codes, ADA, Architectural Graphic Standards, etc.).

2.F.02.02 Draw a plot plan considering civil engineering principles.

2.F.02.03 Draw floor plans (considering appropriate room planning: service, sleeping, and living areas).

2.F.02.04 Draw foundation plan (footings, etc.).

2.F.02.05 Draw interior/exterior elevations.

2.F.02.06 Draw sections.

2.F.02.07 Draw details (framing, window, door, etc.).

2.F.02.08 Draw roof plan.

2.F.02.09 Incorporate door, window and finish schedules.

2.F.02.10 Interpret electrical, plumbing, fireplace, exhaust, and HVAC drawings.

2.F.02.11 Calculate, develop, and layout stairs.

2.F.02.12 Create a set of the above drawings listed as they apply to one building / residence.

2.F.02.13 List common construction material sizes/lengths and describe how these constraints should be considered in design.

2.F.02 Performance Example:

- Produce plans for a simple single-story residence.

2.G Sustainability

2.G.01 Recognize Green Design.

2.G.01.01 Identify product design requirements.

2.G.01.02 Identify architectural design requirements (e.g., (LEED) Leadership in Energy and Environmental Design).

Third Year Drafting

Listed below are additional Categories of Learning, Standards and Objectives beyond the scope of the two year DESE requirement. They are placed in Supplemental Activities and can be used in the third year of a Drafting and Design Technology program.

2.H* ARCHITECTURAL DRAFTING AND DESIGN – *Supplemental Activities*

2.H.01* Calculate dead, live, snow and wind loads on the designed residential house.

2.H.01.01* Determine the tributary area of structural elements on the designed residential house.

2.H.01.02* Trace loads through the building to the foundation.

2.H.02* Redesign a parking lot.

2.H.02.01* Survey an existing parking lot.

2.H.02.02* Redesign the parking lot for maximum usage.

2.H.02.03* Estimate the cost of the redesign of the parking lot.

2.H.03* Determine the heat loss of the designed residential house.

2.H.04* Identify elements of civil design.

- 2.H.04.01* Describe materials and properties used in civil design.
- 2.H.04.02* Identify common civil symbols.
- 2.H.04.03* Identify zoning, environmental, and other regulations and guidelines that impact development.
- 2.H.04.04* Identify surveying instruments.
- 2.H.04.05* Plot using bearings, distances, and coordinates.
- 2.H.04.06* Place utilities, accesses, and contours within size and specifications as described in code.
- 2.H.04.07* Determine acreage.

2.I* COMPUTER AIDED DRAFTING AND DESIGN – *Supplemental Activities*

- 2.I.01* Set up CAD drawing format

Strand 3: Embedded Academics

Strand 3: Embedded Academics, a critical piece of a Vocational Technical Education Framework, are presented as Crosswalks between the Massachusetts Vocational Technical Education Frameworks and the Massachusetts Curriculum Frameworks. These Crosswalks are located in the Appendix of this Framework.

Academic Crosswalks

[Appendix A:](#) [English Language Arts](#)

[Appendix B:](#) [Mathematics](#)

[Appendix C:](#) [Science and Technology/Engineering](#)

Earth and Space Science

Life Science (Biology)

Physical Science (Chemistry and Physics)

Technology/Engineering

Strand 4: Employability and Career Readiness

4.A Career Exploration and Navigation

- 4.A.01 Develop a career plan and portfolio.
 - 4.A.01.01 Develop and revise career plan annually based on workplace awareness and skill attainment.
 - 4.A.01.02 Assess personal strengths and interest areas to determine potential careers, career pathways and career ladders.
 - 4.A.01.03 Examine potential career field(s)/discipline(s) and identify criteria to select, secure and keep employment in chosen field(s).
 - 4.A.01.04 Research and evaluate a variety of careers utilizing multiple sources of information and resources to determine potential career(s) and alternatives.
 - 4.A.01.05 Identify training and education requirements that lead to employment in chosen field(s) and demonstrate skills related to evaluating employment opportunities.
 - 4.A.01.06 Explore and evaluate postsecondary educational opportunities including degrees and certifications available, traditional and nontraditional postsecondary pathways, technical school and apprenticeships, cost of education, financing methods including scholarships and loans and the cost of loan repayment.
 - 4.A.01.07 Create a portfolio showcasing academic and career growth including a career plan, safety credential, resume and a competency profile demonstrating the acquisition of the knowledge and skills associated with at least two years of full-time study in the Chapter 74 program.

- 4.A.02 Demonstrate job search skills.
 - 4.A.02.01 Conduct a job search and complete written and electronic job applications, resumes, cover letters and related correspondence for a chosen career path.
 - 4.A.02.02 Explore and evaluate postsecondary job opportunities and career pathways specific to career technical areas.
 - 4.A.02.03 Identify role and use of social media and networking for staying current with career and employment trends as well as networking, job seeking and career development opportunities.
 - 4.A.02.04 Demonstrate ability to use social media and networking to develop useful occupational contacts, job seeking and career development opportunities.

- 4.A.03 Demonstrate all phases of the job interview process.
 - 4.A.03.01 Gather relevant information about potential employer(s) from multiple print and digital sources, assessing the credibility and accuracy of each source.
 - 4.A.03.02 Identify employment eligibility criteria, such as drug/alcohol free status, clean driving record, etc.

- 4.A.03.03 Practice effective interviewing skills: appearance, inquiry and dialogue with interviewer, positive attitude and evidence of work ethic and skills.
- 4.A.03.04 Explore and evaluate employment benefit packages including wages, vacation, health care, union dues, cafeteria plans, tuition reimbursement, retirement and 401K.

4. A Performance Examples:
- Conduct research to analyze and present on specific careers within a cluster.
 - Conduct web-based job search using sites such as Monster.com, CareerBuilder.com, Indeed.com, Snagajob.com, Simplyhired.com and others.
 - Create profile on social media/networking site such as LinkedIn and/or LinkedIn University for postsecondary research and employment opportunities.
 - Complete online job application.
 - Conduct and videotape practice interviews for instructor and student analysis.
 - Provide students with sample employment and benefit packages for evaluation.

4.B Communication in the Workplace

- 4.B.01 Demonstrate appropriate oral and written communication skills in the workplace.
 - 4.B.01.01 Communicate effectively using the language and vocabulary appropriate to a variety of audiences within the workplace including coworkers, supervisors and customers.
 - 4.B.01.02 Read technical and work-related documents and demonstrate understanding in oral discussion and written exercise.
 - 4.B.01.03 Demonstrate professional writing skills in work-related materials and communications (e.g., letters, memoranda, instructions and directions, reports, summaries, notes and/or outlines).
 - 4.B.01.04 Use a variety of writing/publishing/presentation applications to create and present information in the workplace.
 - 4.B.01.05 Identify, locate, evaluate and use print and electronic resources to resolve issues or problems in the workplace.
 - 4.B.01.06 Use a variety of financial and data analysis tools to analyze and interpret information in the workplace.
 - 4.B.01.07 Orally present technical and work-related information to a variety of audiences.
 - 4.B.01.08 Identify and demonstrate professional non-verbal communication.
- 4.B.02 Demonstrate active listening skills.
 - 4.B.02.01 Listen attentively and respectfully to others.
 - 4.B.02.02 Focus attentively, make eye contact or other affirming gestures, confirm understanding and follow directions.
 - 4.B.02.03 Show initiative in improving communication skills by asking follow-up questions of speaker in order to confirm understanding.

4. B Performance Examples:

- Read and analyze technical instructions to learn what makes them effective.
- Read and analyze technical instructions to follow directions and/or solve a problem.
- Examine a technical document and use it to write a set of instructions for another student to follow and evaluate.
- Analyze websites for effective technical writing and design.
- Create brochures and presentations using software and/or Web 2.0 tools to convey technical information.
- Conduct research using the Internet, print documents, observations and interviews to create a technical guide.

4.C Work Ethic and Professionalism

4.C.01 Demonstrate attendance and punctuality.

4.C.01.01 Identify and practice professional time-management and attendance behaviors including punctuality, reliability, planning and flexibility.

4.C.02 Demonstrate proper workplace appearance.

4.C.02.01 Identify and practice professional appearance specific to the workplace.

4.C.02.02 Identify and practice personal hygiene appropriate for duties specific to the workplace.

4.C.02.03 Identify and wear required safety gear specific to the workplace.

4.C.03 Accepts direction and constructive criticism.

4.C.03.01 Demonstrate ability (both verbally and non-verbally) to accept direction and constructive criticism and to implement solutions to change behaviors.

4.C.03.02 Ask appropriate questions to clarify understanding of feedback.

4.C.03.03 Analyze own learning style and seek instructions in a preferred format that works best for their understanding (such as oral, written or visual instruction).

4.C.04 Demonstrate motivation and initiative.

4.C.04.01 Evaluate assigned tasks for time to completion and prioritization.

4.C.04.02 Demonstrate motivation through enthusiasm, engagement, accurate completion of tasks and activities.

4.C.04.03 Demonstrate initiative by requesting new assignments and challenges.

4.C.04.04 Explain proposed solutions to challenges observed in the workplace.

4.C.04.05 Demonstrate the ability to evaluate multiple solutions to problems and challenges using critical reasoning and workplace/industry knowledge and select the best solution to the problem.

4.C.04.06 Implement solution(s) to challenges and/or problem(s) observed in the workplace.

4.C.04.07 See projects through completion and check work for quality and accuracy.

4.C.05 Demonstrate awareness of workplace culture and policy.

- 4.C.05.01 Display ethical behavior in use of time, resources, computers and information.
- 4.C.05.02 Identify the mission of the organization and/or department.
- 4.C.05.03 Explain the benefits of a diverse workplace.
- 4.C.05.04 Demonstrate a respect for diversity and its benefit to the workplace.
- 4.C.06 Interact appropriately with coworkers.
 - 4.C.06.01 Work productively with individuals and in teams.
 - 4.C.06.02 Develop positive mentoring and collaborative relationships within work environment.
 - 4.C.06.03 Show respect and collegiality, both formally and informally.
 - 4.C.06.04 Explain and follow workplace policy on the use of cell phones and other forms of social media.
 - 4.C.06.05 Maintain focus on tasks and avoid negative topics or excessive personal conversations in the workplace.
 - 4.C.06.06 Negotiate solutions to interpersonal and workplace conflicts.

4. C Performance Examples:

- Complete a learning style analysis tool.
- Develop a rubric to assess work ethic and professionalism as detailed in the standards above.

Student Organizations

Business Professionals of America

www.bpa.org

Selected Websites

- 5 Ways to Ace a Job Interview: http://kidshealth.org/teen/school_jobs/jobs/tips_interview.html
- America’s Career Resource Network: <http://acrn.ovae.org/teachers/careerexpclassrm.htm>
- Career Cruiser – Florida Department of Education:
<http://www.fldoe.org/workforce/pdf/cruiser.pdf>
- Career Development Guide and Glossary: <http://www.doe.mass.edu/connect/cde.html>
- Career One Stop: <http://www.careeronestop.org/>
- Career Plan: <http://www.doe.mass.edu/cd/plan/intro.html>
- Career Plan Model: http://www.doe.mass.edu/ccr/epp/samples/cpmodel_11x17.pdf
- Checklist: <http://www.doe.mass.edu/cd/plan/checklist.pdf>
- Career Tech: http://www.okcareertech.org/cac/Pages/resources_products/ethics_web_sites.htm
- Ethics Resource Center: <http://www.ethics.org/>
- Interaction in the Workplace: <http://hrweb.berkeley.edu/guides/managing-hr/interaction/communication>

- Individual Learning Plans: How-to Guide: “Promoting Quality Individualized Learning Plans: A How to Guide on the High School Years” <http://www.ncwd-youth.info/ilp/how-to-guide>
- ILP Fact Sheet: <http://www.ncwd-youth.info/fact-sheet/individualized-learning-plan>
- ILP Policy Brief: <http://www.ncwd-youth.info/ilp/produce-college-and-career-ready-high-school-graduates>
- ILP Resources Home Page: <http://www.ncwd-youth.info/ilp>
- Interview Skills Lesson Plans:
<http://www.amphi.com/media/1220281/interview%20skills%20lesson%20plan.doc>
- Labor and Workforce Development: <http://www.mass.gov/lwd/employment-services/preparing-for-your-job-search/>
- Maine Community College System – Center for Career Development:
http://www.ccd.me.edu/careerprep/CareerPrepCurriculum_LP-6.pdf
- Massachusetts Work-Based Learning: <http://skillspages.com/masswbl>
- North Dakota Association of Agriculture Educators:
http://www.ndaae.org/attachments/File/Preparing_students_for_a_Job_Interview.pptx
- NY CTE Learning Standards—Career Development and Occupational Studies (CDOS) Resource Guide with Core Curriculum : <http://www.p12.nysed.gov/cte/cdlearn/cdosresourceguide.html>
- Occupational Outlook Handbook: <http://www.bls.gov/ooh/>
- Purdue OWL Job Search Resources (for writing resumes, applications, and letters):
<https://owl.english.purdue.edu/engagement/34/>
- Soft Skills to Pay the Bills — Mastering Soft Skills for Workplace Success:
<http://www.dol.gov/odep/topics/youth/softskills/>
- US Department of Labor: <http://www.dol.gov/dol/audience/aud-unemployed.htm>
- Workplace Communication:
<http://www.regionalskillstraining.com/sites/default/files/content/WC%20Book%201.pdf>
- Your Plan For the Future: <http://www.yourplanforthefuture.org>

Strand 5: Management and Entrepreneurship Knowledge and Skills

5.A Starting a Business

- 5.A.01 Demonstrate an understanding of the practices required to start a business.
 - 5.A.01.01 Define entrepreneurship and be able to recognize and describe the characteristics of an entrepreneur.
 - 5.A.01.02 Compare and contrast types of business ownership (i.e., sole proprietorships, franchises, partnerships, corporations).
 - 5.A.01.03 Identify and explain the purpose and contents of a business plan.
 - 5.A.01.04 Demonstrate an understanding of the principles and concepts of a business's supply chain (i.e., suppliers, producers and consumers).

5. A Performance Examples:

- Develop a presentation pertaining to an entrepreneur and their business.
- Communicate with a business owner and discuss the pros and cons of starting and owning a business. Summarize the main points of the discussion.
- Choose a product or service and describe the process leading to distribution.
- Write a business plan for a business in your community.

5.B Managing a Business

- 5.B.01 Demonstrate an understanding of managing a business.
 - 5.B.01.01 Formulate short- and long-term business goals.
 - 5.B.01.02 Demonstrate effective verbal, written and visual communication skills.
 - 5.B.01.03 Utilize a decision-making process to make effective business decisions.
 - 5.B.01.04 Identify a business's chain of command and define its organizational structure.
 - 5.B.01.05 Identify and apply effective customer service skills and practices.
 - 5.B.01.06 Identify, interpret and develop written operating procedures and policies.
 - 5.B.01.07 Track inventory, productivity and labor cost.
 - 5.B.01.08 Demonstrate business meeting skills.
 - 5.B.01.09 Identify professional organizations and explore their benefits.

5. B Performance Examples:

- Working as a team, role-play situations that an entrepreneur might face in dealing with customers or employees.
- Contact a relevant professional organization and request information about its benefits, membership requirements and costs.
- Plan and conduct a business meeting.
- Identify companies that are known for customer service and list the practices that help differentiate themselves from all others in their industry.

5.C Marketing a Business

- 5.C.01 Demonstrate an understanding of marketing and promoting a business.
 - 5.C.01.01 Explain the role of business in the economy.
 - 5.C.01.02 Describe the relationship between business and community.
 - 5.C.01.03 Describe methods of market research and identifying target markets.

- 5.C.01.04 Describe and apply the concepts of a marketing mix (the 4Ps of marketing: product, price, place and promotion).
- 5.C.01.05 Compare and contrast the promotional tools and techniques used to sell products, services, images and ideas.
- 5.C.01.06 Describe the impact of supply and demand on a product or business.
- 5.C.01.07 Identify direct and indirect competition on a business.
- 5.C.01.08 Identify and use sales techniques to meet client needs and wants.
- 5.C.01.09 Discuss strategies to acquire and retain a customer base.

5. C Performance Examples:
- Research reliable sources to identify marketing and industry data related to a business.
 - Conduct market research by developing a survey and presenting the results.
 - Create a promotional campaign using a variety of media.
 - Write a marketing plan for a product.

5.D Financial Concepts and Applications in Business

- 5.D.01 Demonstrate an understanding of financial concepts and applications.
 - 5.D.01.01 Identify essential financial reports and understand their purpose (i.e., budget, balance sheet and income statement).
 - 5.D.01.02 Describe payroll practices (i.e., deductions – federal, FICA and state taxes and insurances).
 - 5.D.01.03 Identify the importance of maintaining accurate records.
 - 5.D.01.04 Apply practices related to pricing, purchasing and billing.
 - 5.D.01.05 Maintain and reconcile a checking account.
 - 5.D.01.06 Identify the options for funding a business.

5. D Performance Examples:
- Given an employee time card and rate of pay, calculate gross pay, taxes, deductions and net pay.
 - Develop a budget for a simulated business or project.
 - Analyze and discuss financial documents from a company.
 - Research various methods of funding a business.

5.E Legal/Ethical/Social Responsibilities

- 5.E.01 Demonstrate an understanding of legal, ethical and social responsibility for businesses.
 - 5.E.01.01 Identify state and federal laws and regulations related to managing a business.
 - 5.E.01.02 Describe and identify ethical business practices.
 - 5.E.01.03 Demonstrate an understanding of business contracts.
 - 5.E.01.04 Explain the role of diversity in the workplace.
 - 5.E.01.05 Explain the role of labor organizations.
 - 5.E.01.06 Identify practices that support clean energy technologies and encourage environmental sustainability.
 - 5.E.01.07 Demonstrate an understanding of how technology advancements impact business practices.

- 5.E Performance Example:
- Read and interpret a contract.
 - Complete an application for a license, permit or certificate.
 - Research federal, state and local regulations and laws required for a business.
 - Participate in and summarize a discussion with a member of a labor or civil rights organization.

Selected Websites

- CVTE Strand 1, 4, and 5 Resources: <https://sites.google.com/a/mccanntech.org/cvte-strands-1-4-and-5-resources/>
- Entrepreneur: <http://www.entrepreneur.com>
- Inc. Magazine: <http://www.inc.com/>
- Junior Achievement “Be Entrepreneurial Program”: <https://www.juniorachievement.org/web/ja-usa/home>
- Kahn Academy Interviews with Entrepreneurs: <https://www.khanacademy.org/economics-finance-domain/entrepreneurship2/interviews-entrepreneurs>
- Kauffman Founders School: <http://www.entrepreneurship.org/en/founders-school.aspx>
- National Federation of Independent Business: www.nfib.com
- National Foundation for Teaching Entrepreneurship (NFTE): www.nfte.com
- SBA Loans: <http://www.sba.gov>
- SkillsUSA Professional Development Program Competency List: <http://www.skillsusa.org/downloads/PDF/lessons/professional/PDPPreview.pdf>
- Small Business Administration: www.sba.gov

Glossary

| Term | Definition |
|--------------------|---|
| Balance sheet | A statement of the assets, liabilities and capital of a business at a particular point in time. |
| Budget | An estimate of income and expenditure for a set period of time. |
| Business Ownership | Types of business ownership refer to the legal structure of an organization. Legal structures include: Sole Proprietorship, Partnerships, Corporations and Limited Liability Companies. |
| Business Plan | A written document that describes in detail your business goals and how you are going to achieve them from a marketing, operational and financial point of view. |

Term

Chain of Command and Organizational Structure

**Definition**

Refers to the management structure of an organization. It identifies lines of authority, lines of communication, and reporting relationships. Organizational structure determines how the roles, power and responsibilities are assigned and coordinated and how information flows between the different levels of management. (A visual representation of this structure is called an org chart).

FICA

Federal Insurance Contributions Act requires taxes deducted from pay for supporting Social Security.

Income Statement

A financial statement providing operating results for a specific time period showing a business's revenues, expenses and profit or loss.

Market Research

- Primary: Surveys, Focus Groups, Observation
- Secondary: Websites, Internet

Marketing Mix

A set of controlled variables that formulate the strategic position of a product or service in the marketplace. These variables are known as the 4 P's of marketing and include product, place, price and promotion.

Methods to Track Inventory, Productivity and Labor Cost

Refers to the processes a business uses to account for: 1) the inflows and outflows of inventory and materials related to inventory; 2) the efficiency of operations and 3) the cost of labor including salary and benefits.

Promotional Tools and Techniques

The six elements of a promotional mix are: advertising, visual merchandising, public relations, publicity, personal selling and sales promotion.

Supply Chain

The supply chain, or channel of distribution, describes how the product is handled and/or distributed from suppliers with materials, to the manufacturer, wholesaler or retailer and finally to the consumer.

Target Market

Those who are most likely to buy your product or service.

Strand 6: Technology Literacy Knowledge and Skills

6.A Technology Literacy Knowledge and Skills (Grades 9 through 12)

- 6.A.01 Demonstrate proficiency in the use of computers and applications, as well as an understanding of the concepts underlying hardware, software, and connectivity.
 - 6.A.01.01 Use online help and other support to learn about features of hardware and software, as well as to assess and resolve problems.
 - 6.A.01.02 Install and uninstall software; compress and expand files (if the district allows it).
 - 6.A.01.03 Explain effective backup and recovery strategies.
 - 6.A.01.04 Apply advanced formatting and page layout features when appropriate (e.g., columns, templates, and styles) to improve the appearance of documents and materials.
 - 6.A.01.05 Use editing features appropriately (e.g., track changes, insert comments).
 - 6.A.01.06 Identify the use of word processing and desktop publishing skills in various careers.
 - 6.A.01.07 Identify the use of database skills in various careers.
 - 6.A.01.08 Define and use functions of a spreadsheet application (e.g., sort, filter, find).
 - 6.A.01.09 Explain how various formatting options are used to convey information in charts or graphs.
 - 6.A.01.10 Identify the use of spreadsheet skills in various careers.
 - 6.A.01.11 Use search engines and online directories.
 - 6.A.01.12 Explain the differences among various search engines and how they rank results.
 - 6.A.01.13 Explain and demonstrate effective search strategies for locating and retrieving electronic information (e.g., using syntax and Boolean logic operators).
 - 6.A.01.14 Describe good practices for password protection and authentication.
- 6.A.02 Demonstrate the responsible use of technology and an understanding of ethics and safety issues in using electronic media at home, in school, and in society.
 - 6.A.02.01 Demonstrate compliance with the school's Acceptable Use Policy.
 - 6.A.02.02 Explain issues related to the responsible use of technology (e.g., privacy, security).
 - 6.A.02.03 Explain laws restricting the use of copyrighted materials.
 - 6.A.02.04 Identify examples of plagiarism, and discuss the possible consequences of plagiarizing the work of others.
- 6.A.03 Design and implement a personal learning plan that includes the use of technology to support lifelong learning goals.
 - 6.A.03.01 Evaluate the authenticity, accuracy, appropriateness, and bias of electronic resources, including Web sites.
 - 6.A.03.02 Analyze the values and points of view that are presented in media messages.
 - 6.A.03.03 Describe devices, applications, and operating system features that offer accessibility for people with disabilities.

- 6.A.03.04 Evaluate school and work environments in terms of ergonomic practices.
- 6.A.03.05 Describe and use safe and appropriate practices when participating in online communities (e.g., discussion groups, blogs, social networking sites).
- 6.A.03.06 Explain and use practices to protect one's personal safety online (e.g., not sharing personal information with strangers, being alert for online predators, reporting suspicious activities).
- 6.A.03.07 Explain ways individuals can protect their technology systems and information from unethical users.
- 6.A.04 Demonstrate the ability to use technology for research, critical thinking, problem solving, decision making, communication, collaboration, creativity, and innovation.
 - 6.A.04.01 Devise and demonstrate strategies for efficiently collecting and organizing information from electronic sources.
 - 6.A.04.02 Compare, evaluate, and select appropriate electronic resources to locate specific information.
 - 6.A.04.03 Select the most appropriate search engines and directories for specific research tasks.
 - 6.A.04.04 Use a variety of media to present information for specific purposes (e.g., reports, research papers, presentations, newsletters, Web sites, podcasts, blogs), citing sources.
 - 6.A.04.05 Demonstrate how the use of various techniques and effects (e.g., editing, music, color, rhetorical devices) can be used to convey meaning in media.
 - 6.A.04.06 Use online communication tools to collaborate with peers, community members, and field experts as appropriate (e.g., bulletin boards, discussion forums, listservs, Web conferencing).
 - 6.A.04.07 Plan and implement a collaborative project with students in other classrooms and schools using telecommunications tools (e.g., e-mail, discussion forums, groupware, interactive Web sites, video conferencing).

Appendices

The framework teams created an “Appendix” listing potential industry recognized credentials attainable by secondary students; lists of professional, student, and relevant government organizations; and useful resources and websites. **** It is important to note that although most Framework Teams provided information for the “Appendix”, not all teams did. Therefore, sub-headings within the “Appendix” without information have been deleted.***

Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education.

Embedded Academic Crosswalks

Embedded English Language Arts and Literacy

| CVTE Learning Standard Number | Strand Coding Designation Grades ELAs Learning Standard Number | Text of English Language Arts Learning Standard |
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| 2.B, 2.C, 2.D, 2.E, 2.F | SL Grades 9-12 #1 (a-d) | <p>Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grades 9-12 topics, texts, and issues, building on other’s ideas and expressing their own clearly and persuasively.</p> <p>a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.</p> <p>b. Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, and presentation of alternate views), clear goals and deadlines, and individual roles as needed.</p> <p>c. Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.</p> <p>d. Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students participate in various types of discussion on a daily basis, discussing topics as a class, collaborating on projects, and evaluating results with teachers and other students. | | |
| 2.A.03, 2.A.02, 2.D.04 | SL Grades 9-12 #4 | <p>Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students present the plans they created for a simple single-story residence; explaining why they made specific choices in style and materials. | | |
| 2.D.04 | SL Grades 9-12 #5 | <p>Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students will use multimedia tools and media from computer/ internet to incorporate appropriate specification details for detailed mechanical drawings. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | L Grades 6-8 #2 (a, c) | <p>Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <p>a. Use punctuation (comma, ellipsis, dash) to indicate a pause or break.</p> |

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| | | c. Spell correctly. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> When writing or presenting reports, writing papers, or creating finished products, students will use standard English in order to demonstrate professionalism. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | L Grades 9-12, #4 (a,d) | <p>Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.</p> <p>a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word’s position or function in a sentence) as a clue to the meaning of a word or phrase.</p> <p>d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students define technical terms and unfamiliar vocabulary from textbook and other materials, using both context and appropriate reference materials. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | RST Grades pre and Grades 9-12 #1 | <p>(pre) Cite specific textual evidence to support analysis of science and technical texts.</p> <p>(9-10)Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>(11-12)Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students will cite textbook or other materials to support their reasoning in discussion and in writing when appropriate. For example, when discussing manufacturing processes, the student will refer to specific texts as evidence to support an opinion on which is the most cost effective way to complete a task. | | |
| 2.D.04, 2.B.01, 2.E.2.F | RST Grades 11-12 #2 | Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students Given a document that specifies “customer” needs, students will determine the central ideas and create set of appropriate drawings. | | |
| 2.A.01, 2.B.01, 2.D.03 | RST Grades 9-12 #3 | Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students follow multiple steps to complete designs or drawings and then analyze their results, comparing them to models. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | RST Grades 9-12 #4 | Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 and 11–12 texts and topics. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students define technical terms and vocabulary from textbook and other sources, using both context and appropriate reference materials. | | |
| 2.D.06 | RST Grades 9-10 #5 | Analyze the structure of the relationships among concepts in a text, including relationships among key terms. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students design and/or use a combination of simple machines, analyzing the relationships between concepts involved (such force, friction, weight and other variables) | | |

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| 2.A.02 | RST Grades 9-10 #7 | Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Architecture: Given a set of building parameters, students will design a structure to meet the requirements (will translate text to a visual product, i.e. plans). | | |
| 2.A.03 | RST Grades 11-12 #7 | Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students will use available sources such as textbook, technical manuals, and internet media to solve a problem. For example, students redesign a cell phone case according to certain parameters and specifications. | | |
| 2.F.02 | RST Grades 9-10 #9 | Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students will compare and contrast information presented about Green Energy/ Design, evaluating the best/ most appropriate use of these technologies in a given design. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | RST Grades 9-12 #10 | By the end of grade (9,10, 11,12), read and comprehend science/technical texts in the grades 9–CCR text complexity band independently and proficiently. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students read various levels of text (textbook, articles, journals), including the adopted textbook. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-10 #2 (a-f) | <p>Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p> <p>a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.</p> <p>b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic.</p> <p>c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.</p> <p>d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.</p> <p>e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</p> <p>f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students write process, compare-contrast, and other expository papers/ reports when appropriate. For example, students might explain a design process (2.A.03), describe one of the manufacturing processes (2.D.03), or describe and compare architectural styles of buildings (2.E.01) | | |

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| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-12 #4 | Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. |
| Performance Example: <ul style="list-style-type: none"> Students read an article or a chapter from the textbook and write a summary. | | |
| 2.B.01 | WHST Grades 9-12 #5 | Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience |
| Performance Example: <ul style="list-style-type: none"> Notes and annotations on finished designs and drawings must be precise and concise. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-12 #7 | Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. |
| Performance Example: <ul style="list-style-type: none"> After designing and completing scaled drawings for a small cottage (800-1000 square feet) with kitchen, bath, eating and sleeping areas, students build a scaled model from foamboard. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-12 #9 | Draw evidence from informational texts to support analysis, reflection, and research. |
| Performance Example: <ul style="list-style-type: none"> Students read text and write about their findings, citing information from research. For example, students cite text when discussing or defending manufacturing processes. As a reflective activity, Students cite text when evaluating their complete drawings. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-12 #10 | Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. |
| Performance Example: Students will write formally (process papers, informally (journals and logs), and for short periods (exams) as well as revising and using extended periods for projects. | | |
| 2.B, 2.C, 2.D, 2.E, 2.F | SL Grades 9-10 #1 (a-d) | <p>Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grades 9-10 topics, texts, and issues, building on other's ideas and expressing their own clearly and persuasively.</p> <p>a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.</p> <p>b. Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, and presentation of alternate views), clear goals and deadlines, and individual roles as needed.</p> <p>c. Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.</p> <p>d. Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.</p> |
| Performance Example: <ul style="list-style-type: none"> Students participate in various types of discussion on a daily basis, discussing topics as a class, | | |

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| collaborating on projects, and evaluating results with teachers and other students. | | |
| 2.B, 2.C, 2.D, 2.E, 2.F | SL 11-12 #1 (a-d) | <p>Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grades 11-12 topics, texts, and issues, building on other's ideas and expressing their own clearly and persuasively.</p> <p>a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.</p> <p>b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.</p> <p>c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.</p> <p>d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students participate in various types of discussion on a daily basis, discussing topics as a class, collaborating on projects, and evaluating results with teachers and other students. | | |
| 2.B.03, 2.B.02, 2.E.04 | SL Grades 9-12 #4 | <p>Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students present the plans they created for a simple single-story residence; explaining why they made specific choices in style and materials. | | |
| 2.E.04 | SL Grades 9-12 #5 | <p>Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students will use multimedia tools and media from computer/ internet to incorporate appropriate specification details for detailed mechanical drawings. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | L Grades 6-8 #2 (a, c) | <p>Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <p>a. Use punctuation (comma, ellipsis, dash) to indicate a pause or break.</p> <p>c. Spell correctly.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> When writing or presenting reports, writing papers, or creating finished products, students will use standard English in order to demonstrate professionalism. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | L Grades 9-12, #4 (a, d) | <p>Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.</p> |

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| | | <p>a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word’s position or function in a sentence) as a clue to the meaning of a word or phrase.</p> <p>d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students define technical terms and unfamiliar vocabulary from textbook and other materials, using both context and appropriate reference materials. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | RST Grades pre and Grades 9-12 #1 | <p>(pre) Cite specific textual evidence to support analysis of science and technical texts.</p> <p>(9-10)Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>(11-12)Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students will cite textbook or other materials to support their reasoning in discussion and in writing when appropriate. For example, when discussing manufacturing processes, the student will refer to specific texts as evidence to support an opinion on which is the most cost effective way to complete a task. | | |
| 2.E.04, 2.B.01, 2.F, 2G | RST Grades 11-12 #2 | Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Given a document that specifies “customer” needs, students will determine the central ideas and create set of appropriate drawings. | | |
| 2.B.01, 2.C.01, 2.E.03 | RST Grades 9-12 #3 | Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students follow multiple steps to complete designs or drawings and then analyze their results, comparing them to models. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | RST Grades 9-12 #4 | Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 and 11-12 texts and topics. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students define technical terms and vocabulary from textbook and other sources, using both context and appropriate reference materials. | | |
| 2.E.06 | RST Grades 9-12 #5 | Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students design and/or use a combination of simple machines, analyzing the relationships between concepts involved (such force, friction, weight and other variables) | | |
| 2.B,02 | RST Grades 9-10 #7 | Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Architecture: Given a set of building parameters, students will design a structure to meet the requirements (will translate text to a visual product, i.e., plans). | | |

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| 2.B.03 | RST Grades 11-12 #7 | Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students will use available sources such as textbook, technical manuals, and internet media to solve a problem. For example, students redesign a cell phone case according to certain parameters and specifications. | | |
| 2G.02 | RST Grades 9-10 #9 | Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students will compare and contrast information presented about Green Energy/ Design, evaluating the best/ most appropriate use of these technologies in a given design. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | RST Grades 9-12 #10 | By the end of grade (9,10, 11,12), read and comprehend science/technical texts in the grades 9–CCR text complexity band independently and proficiently. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students read various levels of text (textbook, articles, journals), including the adopted textbook. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-10 #2 (a-f) | <p>Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p> <p>a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.</p> <p>b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic.</p> <p>c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.</p> <p>d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.</p> <p>e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</p> <p>f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students write process, compare-contrast, and other expository papers/ reports when appropriate. For example, students might explain a design process (2.B.03), describe one of the manufacturing processes (2.E.03), or describe and compare architectural styles of buildings (2.F.01) | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-12 #4 | Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Students read an article or a chapter from the textbook and write a summary. | | |
| 2.C.02 | WHST Grades 9-12 #5 | Develop and strengthen writing as needed by planning, revising, |

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| | | editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience |
| Performance Example: | | |
| <ul style="list-style-type: none"> Notes and annotations on finished designs and drawings must be precise and concise. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-12 #7 | Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. |
| Performance Example: | | |
| <ul style="list-style-type: none"> After designing and completing scaled drawings for a small cottage (800-1000 square feet) with kitchen, bath, eating and sleeping areas, students build a scaled model from foam board. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-12 #9 | Draw evidence from informational texts to support analysis, reflection, and research. |
| Performance Example: | | |
| <ul style="list-style-type: none"> Students read text and write about their findings, citing information from research. For example, students cite text when discussing or defending manufacturing processes. As a reflective activity, students cite text when evaluating their complete drawings. | | |
| 2.A, 2.B, 2.C, 2.D, 2.E, 2.F | WHST Grades 9-12 #10 | Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. |
| Performance Example: | | |
| <ul style="list-style-type: none"> Students will write formally (process papers), informally (journals and logs), and for short periods (exams) as well as revising and using extended periods for projects. | | |

Embedded Mathematics

| CVTE Learning Standard Number | Math Content Conceptual Category and Domain Code Learning Standard Number | Text of Mathematics Learning Standard |
|--|---|---|
| 2.B.01 | G-MG MA4 | Use dimensional analysis for unit conversions to confirm that expressions and equations make sense. |
| Performance Example: | | |
| <ul style="list-style-type: none"> Take an English dimension and divide by 25.4 to obtain metric units | | |
| 2.B.02 | G-GMD 4 | Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. |
| Performance Example: | | |
| <ul style="list-style-type: none"> Given 3D model or drawing, generate 2D views and appropriate cross sections. | | |
| 2.B.03 | G-MG 3 | Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios). |
| Performance Example: | | |
| <ul style="list-style-type: none"> Given a product, apply the design process to develop new or revised product. Include documentation for each step of process. | | |
| 2.C.01 | G-CO 12, 13, G-GMD 4, 7G 1, 2 | G-CO 12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the |

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| | | <p>perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.</p> <p>G-CO 13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.</p> <p>G-GMD 4. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.</p> <p>7G 1. Solve problems involving scale drawings of geometric figures, such as computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.</p> <p>7G 2. Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Given an object, sketch appropriate views in proportion and/or scale with annotations. | | |
| 2.BC.02 | G-CO 1 | Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Using an existing drawing, apply appropriate dimensioning standards. | | |
| 2.C.03 | 7NS 1, (d) | Apply properties of operations as strategies to add and subtract rational numbers. |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Create an as-built drawing based on actual measurements taken. | | |
| 2.E.01 | NQ 3, (MA.3.a), G-SRT 1 (a, b) | <p>NQ. 3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>MA.3.a. Describe the effects of approximate error in measurement and rounding on measurements and on computed values from measurements. Identify significant figures in recorded measures and computed values based on the context given and the precision of the tools used to measure.</p> <p>G-SRT 1. Verify experimentally the properties of dilations given by a center and a scale factor:</p> <p>a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.</p> <p>b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Set parameters for a new drawing based on project requirements with limitations of levelment accuracy | | |
| 2.D.02 | G-MG 1-3, G-GMD 1,3, GPE 6 | <p>G-MG 1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p> <p>2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).</p> <p>3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</p> |

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| | | <p>G-GMD 1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri’s principle, and informal limit arguments.</p> <p>3. Use volume formulas³ for cylinders, pyramids, cones, and spheres to solve problems.</p> <p>G-GPE 6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Modify or create model based on requirements, record CAD data and create output file. | | |
| 2.E.01 | G-CO 12 | <p>Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Create a flat pattern from its bent up state to find its developed length. | | |
| 2.E.02 | 7RP 1 | <p>Compute unit rates associated with ratios of fractions, including ratios of lengths, areas, and other quantities measured in like or different units. For example, if a person walks $\frac{1}{2}$ mile in each $\frac{1}{4}$ hour, compute the unit rate as the complex fraction $\frac{1/2}{1/4}$ miles per hour, equivalently 2 miles per hour.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Using ratio, size full strength weld. | | |
| 2.E.04 | G-MG 1-3, GMD 1,3, GPE 6 | <p>G-MG 1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p> <p>2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).</p> <p>3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</p> <p>GMD 1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri’s principle, and informal limit arguments.</p> <p>3. Use volume formulas⁴ for cylinders, pyramids, cones, and spheres to solve problems.</p> <p>GPE 6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> Create a layout, detail, and assembly drawing for a simple product (pen, depth gauge, space shuttle). | | |
| 2.E.05 | NRN 3, GC 3,4, NQ 1-3 | <p>NRN 3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number</p> |

³ Note: The 2011 Massachusetts grade 8 mathematics standards require that students know volume formulas for cylinders, cones, and spheres.

⁴ Note: The 2011 Massachusetts grade 8 mathematics standards require that students know volume formulas for cylinders, cones, and spheres.

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| | | <p>is irrational; and that the product of a nonzero rational number and an irrational number is irrational.</p> <p>GC 3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle. MA.3.a. Derive the formula for the relationship between the number of sides and sums of the interior and sums of the exterior angles of polygons and apply to the solutions of mathematical and contextual problems.</p> <p>4. (+) Construct a tangent line from a point outside a given circle to the circle.</p> <p>NQ 1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</p> <p>2. Define appropriate quantities for the purpose of descriptive modeling.</p> <p>3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>MA.3.a. Describe the effects of approximate error in measurement and rounding on measurements and on computed values from measurements. Identify significant figures in recorded measures and computed values based on the context given and the precision of the tools used to measure.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> • Create limit dimensions by adding or subtracting real numbers. | | |
| 2.E.06 | NRN 3 | <p>Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.</p> |
| <p>Performance Example:</p> <ul style="list-style-type: none"> • Find the distance a nut travels in one revolution. | | |
| 2.F.02 | G-MG 1-3, G-GMD 1,3, G-GPE 6 | <p>G-MG 1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).</p> <p>2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).</p> <p>3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</p> <p>G-GMD 1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.</p> <p>3. Use volume formulas⁵ for cylinders, pyramids, cones, and spheres to solve problems.</p> <p>G-GPE 6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.</p> |

⁵ Note: The 2011 Massachusetts grade 8 mathematics standards require that students know volume formulas for cylinders, cones, and spheres.

Embedded Science and Technology/Engineering

Earth and Space Science

| CVTE Learning Standard Number | Subject Area, Topic Heading and Learning Standard Number | Text of Earth and Space Science Learning Standard |
|--|---|---|
| 2.G.01 | Matter and Energy in the Earth System, Earth 1.5 (9-12) | Explain how the revolution of Earth around the Sun and the inclination of Earth on its axis cause Earth's seasonal variations (equinoxes and solstices). |
| Performance Example: | | |
| <ul style="list-style-type: none"> Locate breakfast area on floor plan to maximize morning sun. | | |
| 2.G.01 | Energy Resources in the Earth System, Earth 2.1 (9-12) | Recognize, describe, and compare renewable energy resources (e.g., solar, wind, water, and biomass) and nonrenewable energy resources (e.g., fossil fuels, nuclear energy). |
| Performance Example: | | |
| <ul style="list-style-type: none"> Consider energy needs of a simple single-story residence. | | |

Physical Science (Physics)

| CVTE Learning Standard Number | Subject Area, Topic Heading and Learning Standard Number | Text of Physics Learning Standard |
|---|---|---|
| 2.D.02 | Physical Science - Properties of Matter.2 | Differentiate between volume and mass. Define density. |
| Performance Example: | | |
| <ul style="list-style-type: none"> Calculate volume, mass, and density of cube. | | |
| 2.B.03 | Physical Science – Properties of Matter. 3 | Recognize that the measurement of volume and mass requires understanding of the sensitivity of measurement tools (e.g., rulers, graduated cylinders, balances) and knowledge and appropriate use of significant digits. |
| Performance Example: | | |
| <ul style="list-style-type: none"> Measure object using imperial and metric units; calculate volume and mass; and compare results. | | |

Technology/Engineering

| CVTE Learning Standard Number | Subject Area, Topic Heading and Learning Standard Number | Text of Technology/Engineering Learning Standard |
|--|---|---|
| 2.B.01 | Communication Technologies 3.4 | Identify and explain how symbols and icons (e.g., international symbols and graphics) are used to communicate a message. |
| Performance Example: | | |
| <ul style="list-style-type: none"> Create a drawing using appropriate format and size. Include proper line types, revision, notes, etc. Produce a print to appropriate scale. | | |
| 2.D.02 | Communications Technologies 3.2, 3.3 | 3.2 Identify and explain the appropriate tools, machines, and electronic devices (e.g., drawing tools, computer-aided design, and cameras) used to produce and/or reproduce design solutions (e.g., engineering drawings, prototypes, and reports). |

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| | | 3.3 Identify and compare communication technologies and system, i.e., audio, visual, printed and mass communications. |
| Performance Example: <ul style="list-style-type: none"> Modify or create model based on requirements, record CAD data, and create output file. | | |
| 2.E.03 | Manufacturing Technologies 4.4 | Explain basic processes in manufacturing systems, e.g., cutting, shaping, assembling, joining, finishing, quality control, and safety. |
| Performance Example: <ul style="list-style-type: none"> Students create a presentation and assessment questions on one or more processes. | | |
| 2.F.02 | Construction Technologies | Describe and explain parts of a structure, e.g., foundation, flooring, decking, wall, roofing systems. |
| Performance Example: <ul style="list-style-type: none"> Produce plans for a simple single-story residence. | | |
| 2.B.02 | Engineering Design 1.3 | Produce and analyze multi-view drawings (orthographic projections) and pictorial drawings (isometric, oblique, perspective), using various techniques. |
| Performance Example: <ul style="list-style-type: none"> Given an object, develop a drawing that requires the use of each of the views listed. | | |
| 2.B.03 | Engineering Design 1.1, 1.5 | 1.1 Identify and explain the steps of the engineering design process: identify the problem, research the problem, develop possible solutions, select the best possible solution(s), construct prototypes and/or models, test and evaluate, communicate the solutions, and redesign. 1.5 Interpret plans, diagrams and working drawings in the construction of prototypes or models. |
| Performance Example: <ul style="list-style-type: none"> Given a product, apply the design process to develop new or revised product. Include documentation for each step of process. | | |
| 2.C.03 | Engineering Design 1.4 | Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼" = 1'0", 1 cm = 1 m). |
| Performance Example: <ul style="list-style-type: none"> Create an as-built drawing based on actual measurements taken. | | |
| 2.E.03 | Manufacturing Technologies 7.1 | Describe the manufacturing processes of casting and molding, forming, separating, conditioning, assembling, and finishing. |
| Performance Example: <ul style="list-style-type: none"> Students create a presentation and assessment questions on one or more processes. | | |
| 2.F.02 | Construction Technologies 2.4, 2.6 | 2.4 Calculate the resultant force(s) for a combination of live loads and dead loads. 2.6 Recognize the purposes of zoning laws and building codes in the design and use of structures. |
| Performance Example: <ul style="list-style-type: none"> Produce plans for a simple single-story residence. | | |

DESE Statewide Articulation Agreements

ARTICULATION AGREEMENT

Between

Massachusetts Community Colleges

And

Massachusetts Chapter 74-Approved Secondary
Career/Vocational Technical Drafting Programs

Effective Date: December 2, 2010

for more information, click

<http://www.masscc.org/partnerships-initiatives/voc-schools-articulation-agreements>

Industry Recognized Credentials (Licenses and Certifications/Specialty Programs)

CAD Certifications:

- Solidworks
- Autodesk

Drafting certification:

- ADDA (American Design Drafting Association)

Safety Credential:

- OSHA 10 hour general industry

Resume enhancing items:

- Skills USA participation
- “Live” work experience (in/out of school projects)
- Inclusion of the following included in the Drafting course content:
Hand Sketching, Orthographic Projection, Measurement, Geometric Construction, Dimensioning, Tolerancing, Section and Auxiliary Views, Fasteners, Manufacturing Processes, Architectural Design, Commercial & Residential, Floor Plans, Elevations, Roof Plan and Framing, Foundation Plans, Civil Drawings and Presentation Drawings

Other

Reference Materials

- Exploring Drafting, 11th Edition, By: John R. Walker and Bernard D. Mathis
- Mechanical Drawing: Board and CAD Techniques, By: Jay D Hesel

Related National, Regional, and State Professional Organizations

- ADDA – American Design Drafting Association
- ANSI – American National Standards Institute
- ASME – American Society of Mechanical Engineers
- ASCE – American Society of Civil Engineers
- AIA – American Institute of Architects
- ACTE – Association for Career and Technical Education

Student Organizations

- Skills USA www.maskillsusa.org
- ADDA – American Design Drafting Association