Massachusetts Department of Elementary & Secondary Education

Office for Career/Vocational Technical Education

Vocational Technical Education Framework

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Manufacturing, Engineering & Technology Services Occupational Cluster

Machine Tool Technology (VMACH)

CIP Code 480501

June 2014

Massachusetts Department of Elementary and Secondary Education
Office for Career/Vocational Technical Education
75 Pleasant Street, Malden, MA 02148-4906
781-338-3910
www.doe.mass.edu/cte/

This document was prepared by the
Massachusetts Department of Elementary and Secondary Education
Mitchell D. Chester, Ed.D.
Commissioner

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Massachusetts Department of Elementary and Secondary Education
75 Pleasant Street, Malden, MA 02148-4906
Phone 781-338-3000 TTY: N.E.T. Relay 800-439-2370
www.doe.mass.edu

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Acknowledgements

The Massachusetts Department of Elementary and Secondary Education, Office for Career/ Vocational Technical Education, launched the Vocational Technical Education Framework Revision Project in April 2012. This Framework is the result of that effort and of the contributions of many educators across the state. The Department of Elementary and Secondary Education wishes to thank all of the Massachusetts groups that contributed to the development of these standards and all the individual teachers, administrators, and private sector advisory committee members who provided valuable employer validation of the standards for the Machine Tool Technology Framework of the Manufacturing, Engineering & Technology Services Occupational Cluster.

Contributors to the 2012 Machine Tool Technology Framework (VMACH) Strands 2, 3 and 6:

Project Administrator:
Russell Mangsen, Director of Technical Programs, Assabet Valley Regional Vocational School

Framework Team Leader:
John Allard, Teacher, Assabet Valley Regional Vocational School

Technical Teachers:
David Sommerville, North Shore Technical High School
James Woodward, Blackstone Valley Regional Vocational Technical High School
Ralph Blackburn, Southeastern Regional Vocational Technical School
Scott Botto, Northern Berkshire Vocational Regional Technical High School
Tate Ostiguy, Southern Worcester County Regional Vocational Technical High School
Theryn Jay Blauser, Montachusett Regional Vocational Technical School

Academic Teachers:
Nancy Caparelli, English Teacher, Assabet Valley Regional Vocational School
Jamal Faik, Math Teacher, Assabet Valley Regional Vocational School
James DeBartolomeis, Science Teacher, Assabet Valley Regional Vocational School

Program Advisory Members:
David Jewett, Supervisor, F.H. Peterson
Lee Duerden, Program Coodinator, Quinsigamond Community College
Steve Phillips, Owner, Phillips Precision
Peter Wojnar, Supervisor, Saint Gobain

CVTE Frameworks Project Advisory Committee

Roger Bourgeois, Superintendent/Director
Essex Agricultural and Technical High School
Christine Shaw, Executive Director
Northeast Regional Readiness Center
Peter Dewar, Director of Professional Development
Massachusetts Association of Vocational Administrators
John McDonagh, Grants Coordinator
Southeastern Regional Vocational Technical High School

Massachusetts Department of Elementary and Secondary Education
Patricia Gregson, Associate Commissioner
Vocational, Workforce and College Readiness Programs

Office for Career/Vocational and Technical Education – Framework Revision Strands 2, 3 and 6
Lisa Sandler, Acting State Director of Career/Vocational Technical Education

Maura Russell
Lisa Weinstein
Ramona Foster
Margie Roberts
Karen DeCoster
Janice Crocker

Consultants

Dr. Frank Llamas
Maura McMahon

Contributors to the 2014 Machine Tool Technology Framework (VMACH) Strands 1, 4 and 5:

Project Administrator
Thomas Hickey, Superintendent
South Shore Vocational Technical High School

Project Managers
Rebecca Buck, Northern Berkshire Vocational Regional School District
Kristin Steiner, Northern Berkshire Vocational Regional School District

MAVA Consultants
Kathy Conole Deborah DePaolo John McDonagh

Massachusetts Department of Elementary and Secondary Education
Patricia Gregson, Associate Commissioner
Vocational, Workforce and College Readiness Programs

Office for Career/Vocational and Technical Education – Framework Revision Strands 1, 4 and 5
Lisa Sandler, Massachusetts Methods of Administration Coordinator
Gary Gomes, Accountability & Monitoring Supervisor
Marnie Jain, Education Specialist

Framework Strand 1 Leader:
Michael Nixon, MassBay Community College

Team Members:
Patricia Allen, Greater New Bedford Regional Technical High School
Cheryl Bomal, Greater Lowell Technical High School
Deborah Brightman, Greater New Bedford Regional Technical High School
Martin Dooley, Lower Pioneer Valley Career and Technical Education Center
Darla Hartung, Taunton High School
Rhonda Moran, Lower Pioneer Valley Career and Technical Education Center
John Morash, Plymouth South High School
John Taylor, Greater Lowell Technical High School

Resource Experts:
Anne Gilligan, DESE-Learning Support Service, Safe and Healthy Schools Coordinator
David Edmonds, DESE-CVTE, Education Specialist
Lisa Sandler, DESE-CVTE, Massachusetts Methods of Administration Coordinator

Framework Strand 4 Leader:
Marcia Kessler, Old Colony Regional Vocational Technical High School

Team Members:
Erin Carerra, Taunton High School
Gillian Granger, Blackstone Valley Regional Vocational Technical High School
Carol Hartnett, Blue Hills Regional Technical High School
Christina Melvin, Worcester Technical High School
Cecilia Smith, Greater Lawrence Technical School
EJ Smith, Blackstone Valley Regional Vocational Technical High School
Michael Viggiano, Madison Park High School

Resource Experts:

Gary Gomes, DESE-CVTE, Accountability and Monitoring
Elizabeth Hennessy, Blackstone Valley Regional Vocational Technical High School, Dir. of Counseling
Marnie Jain, DESE-CVTE,
Judith McKinstry, Business Professionals of America Director
Lisa Sandler, DESE – CVTE, Massachusetts Methods of Administration Coordinator
Shailah Stewart, DESE - College & Career Readiness, Connecting Activities Coordinator
Karen Ward, SkillsUSA Director

Framework Strand 5 Leader:

Margaret Ellis, JP Keefe Technical High School

Team Members:

Lori Alie, Blackstone Valley Regional Vocational Technical High School
Lori Carr, Taunton High School
Barbara-jean Chauvin, Norfolk County Agricultural High School
Cheryl Hackenson, Tantasqua Regional High School
Clifford Keirstead, Whittier Regional Technical High School
Lynn McKiernan, Assabet Valley Regional Technical High School
John Oldham, Old Colony Regional Vocational Technical High School
Arlene Thompson, Worcester Technical High School

Resource Experts:

Jennifer Green, Network For Teaching Entrepreneurship Executive Director
Donna McFadden, MA DECA Director
Lisa Sandler, DESE –CVTE, Massachusetts Methods of Administration Coordinator

Massachusetts Department of Elementary and Secondary Education

75 Pleasant Street, Malden, Massachusetts 02148-4906 Telephone: (781) 338-3000
TTY: N.E.T. Relay 1-800-439-2370

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; Stand 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.

Appendix[1]

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 Appendix[2] 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.

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 Fundamentals of Safety in Machine Tool Technology

2.A.01 Demonstrate machine tool safety.

- 2.A.01.01 Utilize personal protective equipment (PPE), following OSHA regulations and industry standards.
- 2.A.01.02 Explain and implement machine guarding.
- 2.A.01.03 Demonstrate safe operation of equipment, following OSHA regulations and industry standards.

2.A.01 Performance Example:

- Students will demonstrate safe operation of equipment, following the rules of the shop. Personal Protective Equipment (PPE) rules will be strictly adhered to. Students will pass safety tests for all equipment before they are allowed to operate said equipment.

2.B Problem Solving

2.B.01 Demonstrate skills in problem solving.

- 2.B.01.01 Identify the problem or source of the problem.
- 2.B.01.02 Predict solutions using a structured problem solving process.
- 2.B.01.03 Apply designated strategies to remedy the given problem.

2.B.01 Performance Example:

- Using appropriate shop project designs, students will identify problems in the manufacturing process. Students will solve these problems using strategies in a group setting or alone.

2.C Machine Maintenance

2.C.01 Manage equipment and machinery.

- 2.C.01.01 Identify appropriate person(s) for maintenance and repair of equipment.
- 2.C.01.02 Review and state equipment indicators to insure that equipment is operating according to manufacturer's specifications.
- 2.C.01.03 Demonstrate ability to maintain equipment.
- 2.C.01.04 Report and maintain a written log for service and repair of equipment.

2.C.01 Performance Example:

- Students will follow a preventative maintenance program developed by the instructors according to machine specifications.

2.D Quality Control

2.D.01 Review inspection procedures.

- 2.D.01.01 Measure work piece with a scale within a tolerance of +/- 1/64.
- 2.D.01.02 Measure work piece outside diameter, inside diameter and depth with the precision instrument to a tolerance of +/- .001.
- 2.D.01.03 Measure work piece with a precision caliper within a tolerance of +/- .005.
- 2.D.01.04 Measure radius on a work piece using a radius gauge.
- 2.D.01.05 Use a protractor to measure the angle(s).
- 2.D.01.06 Measure location and diameter of a feature to a tolerance of at least +/- .001.
- 2.D.01.07 Identify a thread and measure outside and pitch diameter to a tolerance of at least +/- .002.
- 2.D.01.08 Compare surface finish quality of a part using surface finish comparator/gauge to print specification.

2.D.01.09 Define attributes, units, and systems of measurement used in quality control.

2.D.01 Performance Example:
- Students will demonstrate the ability to distinguish among the appropriate precision measuring tools according to allowable tolerances on a given design. Using appropriate measuring tools and a print with specifications, the student will measure and document all dimensions to determine if a product passes inspection.

2.E Material Preparation

2.E.01 Produce general bench work processes.
- 2.E.01.01 Layout flat and/or round stock.
- 2.E.01.02 Cut material using hacksaw to specified length and size.
- 2.E.01.03 File and blend angles and radii on work piece.
- 2.E.01.04 Mark work piece with identification information.

2.E.01 Performance Example:
- Students will use hand tools to prepare material before machining and for finishing the product after the machining process is completed according to product specifications.

2.F Material Sciences

2.F.01 Describe material properties.
- 2.F.01.01 Identify types of metals and related materials.
- 2.F.01.02 List properties that affect machinability.
- 2.F.01.03 Describe heat treatment processes: harden, temper, anneal, normalize, and case harden.

2.F.01 Performance Example:
- Through research and discovery, students will identify material properties that have a direct effect on its machinability.

2.G Blueprints

2.G.01 Read blueprints and create basic sketches.
- 2.G.01.01 Read and interpret detail drawings to meet American National Standards Institute (ANSI) and International Organization for Standards (ISO) standards.
- 2.G.01.02 Read and interpret assembly drawings.
- 2.G.01.03 Design and sketch a basic work piece including mathematical annotation.

2.G.01 Performance Example:
- Students will build and assemble products according to detailed drawings and annotated hand sketches. This will include the interpretation of prints with geometric dimensioning and tolerance symbols that meet ANSI and ISO specifications.

2.H Process Planning

2.H.01 Plan production process.
- 2.H.01.01 Determine and select appropriate material, size and quantity needed to complete specified product(s).
- 2.H.01.02 Formulate an order of operations, proper tooling and workholding devices.

2.H.01 Performance Example:
- Students will research all materials and tooling needed to build a product from the curriculum. Students will design a production plan that will satisfy the steps needed to create the project from start to completion.

2.I Machining Operations

2.I.01 Demonstrate general machining operations.

- 2.I.01.01 Drill a hole to the designated size and in the predetermined location.
- 2.I.01.02 Countersink a hole to depth and diameter specified by blueprint and/or standard.
- 2.I.01.03 Ream a hole to a specified tolerance of +/- .001.
- 2.I.01.04 Tap a hole to specified depth and thread size.
- 2.I.01.05 Counter bore a hole to the specified diameter and/or depth according to the blue print.
- 2.I.01.06 Calculate speeds and feeds for given tooling and material.

2.I.01 Performance Example:

- Using shop developed projects and tasks, students will perform machining operations that are relevant to a multitude of machines.

2.J Power Saw Processes

2.J.01 Operate a power saw.

- 2.J.01.01 Choose the appropriate blade for specified task.
- 2.J.01.02 Cut material using horizontal saw to specified length.
- 2.J.01.03 Use a vertical band saw to cut along layout lines.

2.J.01 Performance Example:

- Students will demonstrate the use of power saw equipment and cut material for the creation of shop designed projects and tasks.

2.K Finishing Processes

2.K.01 Demonstrate offhand grinding and finishing operations.

- 2.K.01.01 Explain the selection and process of finishing techniques.
- 2.K.01.02 Dress wheel, set tool rest and spark guard on pedestal grinder to proper height and clearance.
- 2.K.01.03 Deburr work piece.
- 2.K.01.04 Explain and demonstrate the grinding of tools for specific application and use.

2.K.01 Performance Example:

- Through classroom work and shop projects, students will demonstrate the operations of offhand grinding for the completion of a product and sharpening of tools associated with the trade.

2.L Grinding Processes

2.L.01 Practice precision grinding.

- 2.L.01.01 Demonstrate mounting of a grinding wheel according to industry standards.
- 2.L.01.02 Demonstrate precision grinding operations.

2.L.01 Performance Example:

- Using industry standard equipment and classroom theory, students will demonstrate precision grinding operations using the tools associated with the production of square and cylindrical finished products.

2.M Lathe Processes

2.M.01 Practice precision turning.

- 2.M.01.01 Identify and setup workholding devices including universal and independent chucks and collets.

2.M.01.02 Demonstrate outside turning procedures, including facing, grooving, turning diameters to a shoulder, and tapering to a specified tolerance.
2.M.01.03 Demonstrate inside turning procedures, including boring, grooving and tapering to a specified tolerance.
2.M.01.04 Demonstrate single-point threading to a specified tolerance.
2.M.01.05 Demonstrate cut-off techniques.
2.M.01.06 Machine a form into the work piece.
2.M.01.07 Knurl a piece to design specifications from blue print.
2.M.01.08 File and polish a work piece.

2.M.01 Performance Example:
- Students will demonstrate skills in the turning of cylindrical and square stock through the completion of shop designed projects and tasks. Through the selection of appropriate work holding devices, students will demonstrate a working knowledge set up and fixtures needed for the completion of machining processes.

2.N Milling Processes

2.N.01 Use precision milling.
2.N.01.01 Indicate vise within a tolerance of .001 over a 6" span.
2.N.01.02 Tram milling head within a tolerance of .001 over a 6" diameter sweep.
2.N.01.03 Locate a datum feature using an edge finder.
2.N.01.04 Locate and indicate holes and pins.
2.N.01.05 Mill a flat surface within a specified surface finish using a variety of tooling.
2.N.01.06 Mill a variety of angles within a specified tolerance.
2.N.01.07 Square a work piece within a specified tolerance.
2.N.01.08 Demonstrate climb and conventional milling.
2.N.01.09 Mill a shoulder, slots and pockets within a specified tolerance.
2.N.01.10 Demonstrate setup and operation of a boring head.
2.N.01.11 Bore a hole to size and location within a tolerance of +/- .005.
2.N.01.12 Describe the operation of keys and keyways.
2.N.01.13 Mill keyways and keyseats to specifications.

2.N.01 Performance Example:
- Students will demonstrate skills in the set up and milling of shapes and surfaces using cylindrical and square material through the completion of shop designed projects and tasks. Using industry standard locating tools, students will demonstrate a working knowledge of datum's to set-up and machine a finish product.

2.O CNC Programming

2.O.01 Demonstrate and apply the Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) process.
2.O.01.01 Demonstrate basic CAD operations using current industry standard software. Use computer aided manufacturing (CAM) software to apply machining processes to design (e.g., speeds, feeds, cutter compensation, etc.).
2.O.01.02 Post process program and transfer to and from CNC machine.

2.O.01 Performance Example:
- Using industry standard CNC equipment and classroom theory, students will demonstrate a working knowledge of a written program and the different codes that are associated within it. Students will demonstrate the operation of the control panel to set up, run, and edit a program for a shop designed project.

2.P CNC Operations

2.P.01 Operate CNC and conversational machines.

- 2.P.01.01 Construct a safe and effective part program using G&M codes.
- 2.P.01.02 Use Manual Data Input (M.D.I.) and control panel operations including simple programming, tool changes and spindle speeds.
- 2.P.01.03 Demonstrate sequential start-up and shut down operations.
- 2.P.01.04 Set up datum point, tool length offsets and tool geometry offsets.
- 2.P.01.05 Set cutter compensation.
- 2.P.01.06 Load programs, dry run, edit, and execute program.

2.P.01 Performance Example:

- Using Industry standard software, students will design and apply machining processes for the completion of shop projects and tasks. Students will demonstrate the process of posting and receiving of programs to a CNC machine to properly complete a project to shop specifications.

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	Definition
Chain of Command and Organizational Structure	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
2A-2P	L6 Grades 9-10 and Grades 11-12	Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.
2A, 2B, 2C, 2E, 2F, 2G, 2M, 2N, 2O	RST4 Grades 9-10 and Grades 11-12	Interpret Words and phrases as they are used in a text, including determining technical connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
2A, 2C, 2E, 2F, 2H, 2O, 2P	WHST4 Grades 9-10 and Grades 11-12	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
2A, 2B,, 2L	SL1 c, d Grades 9-10 and Grades 11-12	Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
Performance Example: • Students will produce coherent writing, using general and specific wording in the development of process plans that are appropriate to the tasks.		
2B, 2C,2F, 2G, 2M, 2N, 2O, 2P	RST1 Grades 9-10 and Grades 11-12	Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
Performance Example: • Students will exhibit the ability to understand the written word through the completion of projects using problem solving techniques.		
2G, 2H, 2K, 2L, 2M, 2N, 2O	SL4 Grades 9-10 and Grades 11-12	Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose and audience.
2O, 2P	WHST4 Grades 9-10 and Grades 11-12	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Performance Example: • Students will present their written and performance work using multiple disciplines of communications including but not limited to verbal and the written word.		

Embedded Mathematics

CVTE Learning Standard Number	Math Content Conceptual Category and Domain Code Learning Standard Number	Text of Mathematics Learning Standard
2.B, 2H	N-Q	Reason quantitatively and use units to solve problems.
Performance Example: • Students will demonstrate problem solving abilities using units of measurement in the development and implementation of a production process plan.		

2.E, 2.N	7.G	Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.
2.G,2P	7.G	Draw, construct, and describe geometrical figures and describe the relationships between them
Performance Example: • Students will identify and calculate for omitted angles and geometry in the production of projects and tasks along with related theory components.		
2.G, 2.H	7.NS	Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.
Performance Example: • Using foundational concepts of arithmetic students will calculate missing dimensions in the creation of projects and tasks.		
2.I	7.EE	Solve real-life and mathematical problems using numerical and algebraic expressions and equations.
Performance Example: • Students will calculate cutting speeds, feeds, and rpms using algebraic expressions.		
2.L , 2.N, 2.O	8.G	Understand and apply the Pythagorean Theorem. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.
2.G, 2.M,2I	7.G, 8.G	Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.
2.P	G-GMD	Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
Performance Example: • Students will use formulas and functions to calculate missing information for the creation of projects and tasks with a related theory component.		

Embedded Science and Technology/Engineering

Physical Science (Chemistry)

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Chemistry Learning Standard
2.F,2K,2L	P3.4	Explain the relationships among temperature changes in a substance, the amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.
Performance Example: • Students will be introduced to the relationships of heat transfer between tools and materials during the grinding, milling and lathe processes.		

Technology/Engineering

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Technology/Engineering Learning Standard
2.A, 2.C, 2D, 2H, 2J, 2K, 2L, 2M, 2O	TE2.5	Identify and demonstrate the safe and proper use of common hand tools, power tools, and measurement devices used in construction.
2.A, 2.C, 2F, 2H, 2K, 2L, 2M, 2O	TE7.2	Identify the criteria necessary to select safe tools and procedures for a manufacturing process (e.g., properties of material, required tolerances, end uses.
Performance Example: • Students will identify and demonstrate the safe usage of power and hand tools that are needed for the completion of tasks or components within a project.		
2.B,2G	TE1.1	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 solution, redesign.
Performance Example: • Using real world problems and examples, students will identify the steps that are needed in order to complete a given task.		
2.B,	TE1.2	Understand that the engineering design process is used in the solution of problems and the advancement of society. Identify examples of technologies. Objects and processes that have been modified to advance society, and explain why and how they were modified.
Performance Example: • Students will research a given problem that has been altered due to the advancement of technology for the betterment of society.		
2.E,2G	TE1.3	Produce and analyze multi-view drawings (orthographic projections) and pictorial drawings (isometric, oblique, perspective), using various techniques
2.E,2G	TE1.4	Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼”=1’0”, 1 cm = 1 m
2.E,2G	TE1.5	Interpret plans, diagrams, and working drawings in the construction of prototypes or models.
2.F, 2.H	TE2.1	Identify and explain the engineering properties of materials used in structures (e.g., elasticity, plasticity, R value, density, strength).
Performance Example: • Students will create and interpret drawings in the production of projects and tasks.		

DESE Statewide Articulation Agreements

No Statewide Articulation Agreements at this time.

Industry Recognized Credentials (Licenses and Certifications/Specialty Programs)

Manufacturing Advancement Center Workforce Innovation Collaborative (MACWIC) Certification

All students will be eligible for level 1&2 testing, at what time students are tested will be decided by their teachers. MACWIC is presently revising/developing exams for Level 1 & Level 2 certificate testing, the exams are aligned with the new CVTE core frameworks and a post-secondary pathway. The exams will be proctored by a local industry representative (i.e. Program Advisory Committee (PAC) member or other local MACWIC representative). MACWIC is planning to provide the exam and issue certifications to students beginning in School Year 2012-2013.

Applied Manufacturing Technology Certification Pathway

Level 1

Shop Math: Students will be able to understand basic math concepts and terms as well as recognize the symbols that represent them. They will be able to solve basic problems with and without the use of a calculator. Students will be able to compute basic mathematical equations required to perform related tasks on the shop floor.

Blueprint Reading: Students learn how to read and interpret technical drawings (blueprints). They gain a fundamental understanding of the critical role the technical drawing plays with respect to work process, quality control and a product's critical features.

Metrology: Attain a basic level of competency in the use of precision measurement tools that will allow them to monitor and validate the production outputs related to the precision parts making process. Students gain a solid foundation of knowledge and skill in performing measurements and calculations. The student learns to use precision measurement tools, such as steel rule, tape measure, protractor, micrometer, height gage, calipers and dial indicators. Students gain proficiency selecting the proper tools for inspecting parts and in preparing quality control inspection reports.

Team Involvement Problem Solving: An accelerated skill building workshop that trains participants how to effectively use a structured team-based approach to find and eliminate the root cause of costly performance problems.

Work Readiness: Skills including world-of-work awareness, labor market knowledge, occupational information, values, clarification and personal understanding, career planning and decision making, and job search techniques (resumes, interviews, applications, and follow-up letters). They also include positive work habits, attitudes, and behaviors such as punctuality, regular attendance, presenting a neat appearance, getting along and working well with others, exhibiting good conduct, following instructions and completing tasks, accepting constructive criticism from supervisors and co-workers, showing initiative and reliability, and assuming the responsibilities involved in maintaining a job.

Level 2

(MassMEP's Level 2 training has the following additional credentials: MA Division of Apprentice Training pre-apprentice certificate, 3 elective credits in Quinsigamond Community College's Manufacturing Technology A.S. degree program)

Safety: Students learn the fundamentals of machine shop safety. Students learn the importance of recognizing critical safety features related to the equipment they will ultimately work with. They will be oriented to location of exits, fire extinguishers, fire blankets, eye wash stations, emergency stops and panic buttons. The training covers the importance of ear and eye protection. Students are oriented to the requirements of injury and accident reporting. A safety test is used to assure that the student has successfully absorbed the material and training.

CNC Milling: CNC milling technology introduces students to fundamentals of CNC (Computer Numerical Control) milling. Students work on a variety of machining applications learning fundamentals by working with industrial based equipment to machine complex parts. Students gain hands on experience in machine set-up, cutting tool function, tool path simulation and machining center operation.

CNC Turning: CNC turning technology introduces students to the fundamentals of CNC turning working with industrial based equipment to machine parts. The modules and related activities challenge students to develop a basic program. Ultimately the students will be machining complex precision parts.

CNC Programming: CNC programming compliments the CNC turning and CNC milling modules. Students learn new G&M code commands, enabling them to write and understand basic NC programs. The students use software that provides them an animated simulation of the machining process.

GD&T: Present an overview of Geometric Dimensioning and Tolerancing to familiarize the student on its use and application on the shop floor. The materials are based on the ASME Y14.5M – 1994 standard.

Other

Reference Materials

- Machine Trade Print Reading: Michael A. Barsamian- Mechanical Drafting, Print Reading Instructor, Gateway Technical College, Richard A. Gizelbach, CNC Instructor, Gateway Technical College
- CNC Programming: Lathe, By: Matthew Manton and Duane Weidinger
- Machine Fundamentals, By: John R. Walker

Related National, Regional, and State Professional Organizations

- MACWIC – Manufacturing Association Workforce Innovation Collaborative
- NTMA – National Tooling and Manufacturing Association
- BTMA – Boston Tooling and Manufacturing Association
- SME – Society of Manufacturing Engineers

Student Organizations

- Skills USA www.maskillsusa.org

Selected Websites

- http://www.macwic.org/