Technology/Engineering Advisory Council
Massachusetts Department of Elementary and Secondary Education
FY2007-2008 Annual Report

I. EXECUTIVE SUMMARY

The Council's main focus this year was to support the case for having Technology/Engineering courses counted as core academic science requirements for state College and University admissions. Currently the Department provides for Technology/Engineering courses to count as science for high school graduation, as indicated in the Massachusetts Recommended High School Program of Studies (MassCore). Key to making the case that this should apply to state higher education admissions is showing that Technology/Engineering courses are academic in nature, rigorous in content, and meet the existing state Framework that already define them as a science. The council collected and reviewed syllabi from high school courses that are intended to fulfill science requirements, and can show how these courses are indeed scientific in nature and comparable to other academic science courses. In doing so, the council also noted the need to learn more about the way Technology/Engineering is taught across the state, particularly in the middle grades where it is part of the Science and Technology/Engineering Learning Standards for all students and is tested on the Grade 8 Science and Technology/Engineering MCAS. It also became clear that a collection of resources for MA teachers including syllabi, projects, teaching ideas, etc. would be useful and the council started working to compile useful websites and other resources.

II. INTRODUCTION

The role of the Technology/Engineering Advisory Council is to advise the Department of Elementary and Secondary Education and the Commissioner on matters pertaining to Technology/Engineering and the Learning Standards articulated in the Science and Technology/Engineering Curriculum Framework. As part of our mission to promote scientific and technological literacy and improve the teaching and learning of Technology/Engineering in K-12 schools, the Council seeks to help the Department encourage Technology/Engineering courses in school districts. At the high school level, these courses are being offered as core academic science and are academically comparable to physics, chemistry and biology. These courses are also incorporated into the MCAS. While more resources are now available for teachers to offer and teach this subject, districts may decline to offer courses and/or students may be deterred from taking them because they may not help satisfy the science requirements for state college admission.

Great strides have been in having Technology/Engineering fully counted as a scientific discipline in other arenas. The National College Athletic Association (NCAA) now accepts Technology/Engineering course as natural/physical science in its college admission standards, and the NCLB legislation provides for the inclusion of Technology/Engineering as a science to fulfill testing requirements. The Council acknowledges the work done by our Department of Elementary and Secondary Education liaison Jake Foster in accomplishing these goals and will continue to support Department staff as we work to have Technology/Engineering fully recognized as scientific subject area.

III. 2007-2008 ISSUES AND ACTIONS

1. Inclusion of Technology/Engineering Courses as Science Courses in MassCore requirements

MassCore recommends that all students take three laboratory-based science courses for high school graduation. Individual school districts are making the decision to count Technology/Engineering as fulfilling their science requirements for graduation. However, Technology/Engineering courses are currently not recognized by the Massachusetts Department of Higher Education as fulfilling the science requirement for admission to state colleges. The problem facing Technology/Engineering teachers and those supporting this type of course offering is that guidance counselors might dissuade students from taking these courses so that they would have the required courses for state college admission. This inconsistency led to a key area of work for the Council this past year.

In our efforts to support Technology/Engineering course offerings the Council worked to help make a case summarized current progress toward the inclusion of Technology/Engineering courses as core science courses:

- By incorporating Technology/Engineering into the Science Frameworks for K-12, the state has made the assertion that this subject is now part of the academic core.
- Students may fulfill federal NCLB science requirements and state high school graduation requirements by taking the Technology/Engineering MCAS test.
- The NCAA now recognizes Technology/Engineering as fulfilling its requirements from students entering college.

The Council recognizes that there is a wide variety of "technology" course offerings, but those called "Technology/Engineering" are expected to meet the state curriculum framework and provide students with a rigorous academic approach to technology and engineering subjects.

The best way for Technology/Engineering teachers to support the inclusion of our courses in MassCore is to provide syllabus examples that demonstrate how these courses are rigorous, academic, and in compliance with the state frameworks. Another important part of the case is to identify professional organizations that support Technology/Engineering teachers by providing access to resources and professional development. Finally, better aligned licensure test for Technology/Engineering teachers will help to show that teachers of this subject have comparable training to teachers of traditional sciences.

A discussion of each of these issues follows.

2. Technology/Engineering course syllabi examples

The need for good example syllabi is twofold. As discussed above it provides proof of the scientific nature of the course, and second they provide excellent resources for schools/teachers wanting to start or improve their technology/engineering offerings. The council looked for syllabi that met the following guidelines:

1. Topics are academic in nature and aligned with the standards
2. Resources and references are clear
3. Student activities are clear
4. Assessments may be included

The Council collected and reviewed syllabi from council membership and others as available. The council noted that many of the syllabi we reviewed had these properties in common:

- The courses do meet the MA curriculum frameworks for a full-year $9^{th}/10^{th}$ grade course in Technology/Engineering.
- The resources cited are professionally recognized
- Student activities are engaging and include a combination of reading, writing, creative, and hands-on activities
- The content included connections between technology/engineering and math, science, and other academic courses.

Two sample high school Technology/Engineering course syllabi are included as Attachments I and II to this report (provided by Council members Susan Sanford and Mark Kobel). The formats in these two samples, and in essentially all collected syllabi, are different.

We also reviewed Advanced Placement course syllabi for comparison of format and style to see if there was a prescribed format for these courses. The AP site has a page with several sample syllabi, contributed by teachers, for all the courses they offer exams for: http://apcentral.collegeboard.com/apc/public/courses/syllabi/index.html. A review of this site shows that each syllabus is in a different format.

It appears that asking teachers or schools to document their courses in one universal format would be unworkable, and likely be unnecessary, as the same ideas and activities can be communicated in many different ways.

3. References for Technology/Engineering teachers:

It was recommended that a Website/Resource Directory for Technology/Engineering teachers be compiled and made available to teachers across the state. The site could be organized as shown in Attachment III. There are many, many more resources that could be referenced, but a few are included in Attachment III. (Move all the bullets below to a new appendix…there can only be 5 pages in this portion of the report)

4. MCAS student survey questions

The 8^{th} grade Science & Technology/Engineering MCAS test contains several questions asking students about the structure and the teaching of their Technology/Engineering classes. The council reviewed the existing questions and found them likely to be confusing for students, with choices that would not be pertinent to their program. These questions present an opportunity to learn about how Technology/Engineering courses are being implemented across the state and could give us guidance regarding the needs of Technology/Engineering teachers and their supervisors.

Members of the council reviewed these questions and are interested in providing input on them for better information gathering. The council explored alternative phrasing for these questions but put the issue aside for the time being with plans to explore this opportunity in the future.

5. MTEL Revisions

In past years the Technology/Engineering Massachusetts Teacher's Education and Licensure (MTEL) test has been acknowledged by this council as a potential barrier to candidates for Technology/Engineering teaching positions. Topics and questions did not seem to focus on the skills essential for teachers of Technology/Engineering and have been skewed towards the industrial arts influences in the discipline. We learned this year from our liaison Jake Foster that the Technology/Engineering MTEL licensure test is now being revised to be put in the same format, same cycle and comparable rigor to the other sciences. Therefore the test will be updated on the same schedule as other science disciplines and has content at a similar level.

IV. RECOMMENDATIONS

The following issues are considered important for the Department of Elementary and Secondary Education and the Commissioner to understand and keep in mind when making decisions:

- Technology/Engineering courses are valid scientific disciplines and should fulfill the MassCore Science requirements of the Board of Higher Education;

- Districts should be supported in offering Technology/Engineering courses as Science credits;

- Professional development opportunities for Technology/Engineering teachers and courses should be supported and encouraged.

V. ADVISORY COUNCIL DETAILS

Administrator: Barbara Libby blibby@doe.mass.edu
Council Liaison: Jacob Foster jfoster@doe.mass.edu
Chairperson: James Alicata jalicata@admin.fsc.edu
Council Secretary: Diane Brancazio dbrancazio@belmont.k12.ma.us
Web page URL: http://www.doe.mass.edu/boe/sac/tech

Members of the 2007-2008 Advisory Council

First	Last	Title/role	Institution/representation
James	Alicata	Chair, Industrial Technology Department	Fitchburg State College
John	Boudreau	Teacher	Fall River Public Schools
Diane	Brancazio	HS & MS Teacher	Belmont Public Schools
Johanna	Bunn	Teacher Educator	Museum of Science
Jonathan	Dietz	Middle School Teacher	Weston Public Schools
Bradford	George	Technology Middle School Teacher	Stow Public Schools
Mark	Kobel	Technology/Engineering High School Teacher	Gardner Public Schools
William	Manser	Teacher/TEAM Board	Ashburnham/Westminster Regional School District
Douglas	Prime	Executive Director, Future Engineers Center	University of Massachusetts, Lowell
Anthony	Ruscito	Technology Middle School Teacher	Bedford Public Schools
Susan	Sanford	Technology/Engineering Teacher	Worcester Public Schools
Yvonne	Spicer	Vice President	National Center for Technological Literacy

Council Meeting Dates

November 17, 2007	Fitchburg State College, Fitchburg
December 18, 2007	Marlborough High School, Marlborough
January 15, 2008	University of Massachusetts, Lowell
March 7, 2008	Fitchburg State College
April 15, 2008	Doherty High School, Worcester
May 13, 2008	Minuteman Regional High School, Lexington
June 3, 2008	Museum of Science, Boston

Attachment 1

Technology/Engineering Syllabus

Prepared by: Mark Kobel, Gardner High School. 200 Catherine Street, Gardner, MA 01440
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The included curriculum matrix is based on a template created by Susan Sanford, Seth Desilets, John Gionet, Nick Grout, Dan DeLollis, and Mark Kobel during the Curriculum Methods graduate class at Fitchburg State College, during the summer of 2007.

Text and Reference Materials:
Wright, Technology Goodheart-Willcox, 2004
Brusic, Fales and Kuetemeyer, Technology: Engineering & Design Glencoe/McGraw-Hill, 2008
Massachusetts Framework for Science and Technology /Engineering
(http://www.doe.mass.edu/omste/ca.html)
Technology Education Learning Activities (Prepared by Teacher)

Course Description:
Technological literacy is essential for success in our world. This course introduces students to various Science and Technology/Engineering concepts and principles that will increase their understanding and ability to manage technological systems. Students will engage in activity based learning which incorporates the areas of science and mathematics, in order to enhance their critical thinking skills to help them solve complex problems. This course emphasizes the "thinking" and "doing" goals detailed in the Massachusetts Science and Technology/Engineering frameworks.

Course Objectives:
As a result of their experiences in the technology/engineering program, students will:

Increase technologically literacy.
Apply problem solving strategies in varied situations.
Explore the strands of Science and Technology/ Engineering framework.
Acquire knowledge, develop skills, and form attitudes that will allow them to compete in the world's Technological market.
Recognize the relationships between other disciplines and their interconnectedness with Technology/Engineering.

Learning Expectations:
A comprehensive set of Learning Standards from the Technology/Engineering Learning Standards for a Full First-Year Course in Grades 9 or 10 are found in the Massachusetts Curriculum Frameworks for Science and Technology/Engineering, Revised 2006. (http://www.doe.mass.edu/omste/ca.html)

These learning standards are listed in the accompanying schedule of class activities.

Instructional Methods:
Reading, lecture, Internet information gathering, hands-on activities, video, individual and group study, writing, and lab demonstrations.

Assessment/Grading:

35% Tests and quizzes - Multiple choice, matching, short answer, and long form essay.
30% Project work – Presentations and hands on activities.
25% Written work – Activity reports, homework, chapter questions from text.
10% Final Exam

Attendance and Participation:

Regular attendance is essential to success. Students are expected to be in school every day.

Participation in discussions, hands-on learning activities, and project work is expected.

Interacting with faculty and peers in a positive manner is expected.

Students must possess and/or develop a strong work ethic, positive teamwork skills, respect the rights of peers and teachers, and accept personal responsibility for their actions.

Students are expected to be prepared for class with a notebook, pen/pencil, and proper attire when required for assignments/lab work.

Students are expected to demonstrate proper use, care, and respect for lab equipment.

Cell Phone etiquette: "Cellular phones and any electronic device capable of transmitting and/or receiving audio or a text message are not to be turned on during school hours." - From the GHS Student Handbook. A phone in use or ringing will be confiscated. The owner will be required to retrieve it after school. A second offense will result in the phone being turned in to the principal.

Make up policy: "Students are responsible for arranging with teachers to make up work missed" – from the GHS Student Handbook

Work due on the day of an absence is due upon the student's return. A test/quiz on the day of an absence is to be completed on the day student's return either during a study or before or after school. Work assigned on a day of an absence is due in the same time frame as originally assigned. "Telecommunication" with classmates is encouraged in order to get missed assignments.

Plagiarism: "Copying of material from any source, for a paper or report, or submitting someone else's work as one's own…will result in an automatic zero for that activity."- from the GHS Student Handbook

Computer use: Each student is responsible for knowing their username and password and keeping them private. Students must have signed an acceptable use policy form and are expected to abide by its rules, which may be summarily stated as: Use the school's computers to do school work-ONLY! Your school time is your work time. Personal activities are to be done on your time outside of school

Gardner High School

Mission Statement: The mission of Gardner High School is to enable all students to be educated, productive, responsible citizens in a changing global society. We provide an education that promotes academic, personal and social growth and achievement. Our school, in cooperation with families and community, ensures a safe learning environment; a challenging, standards-based curriculum; and appropriate use of technology and instruction materials. Gardner High School fosters diversity and mutual respect.

FRAMEWORKS	OBJECTIVES - The student will:	ACTIVITY	TEXT	ASSESSMENT	CLASS PERIODS
1.1 Identify and explain the steps of the engineering design process.	1 Experience a teamwork project. 2 Complete a problem solving exercise using the Engineering Design Process. 3 Efficiently utilize the school's computer network.	**The Engineering Design Process** -Icebreaker project “Tower Design” -Digital Portfolios setup -Create Personal Folders from a template -Review of basic computer literacy	Teacher created handout sheets	Engineering Design Process Quiz Computer Terminology & Processes Quiz	5
1.2 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.	1 Explain how technology has advanced society. 2 Explain how the engineering design process has been applied to solve a societal problem. 3 Using the internet, find an illustrated example of a historical technological advancement of society, create a hand drawn illustration for a classroom technology timeline.	**The Evolution of Technology** -PowerPoint Lesson/worksheet Text reading and notes -Historical "ages" -Discussion and writing assignment: Technology and Advances in Society	Text: **Technology** by Wright pp.24-29	Technology & Society Quiz Research Document	5
1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings, such as, ¼” = 1’0”, 1 cm = 1 m.	1 Explain how documents and drawings are used to communicate information. 2 Develop techniques for estimating proportion. 3 Explain the documents and drawings used to communicate information. 4 Develop techniques of Sketching.	**Drafting Principles** Text reading and notes - Techniques of Sketching - Analyzing and estimating - Draw Sketches	Text: **Technology** by Wright pp.224-239 Text: **Technology: Engineering & Design** by Brusic pp.151-161, 254 -256, 348	Measurement Quiz Scale Quiz Sketches	5

1.3 Produce and analyze multi-view drawings (orthographic projections) and pictorial (isometric, oblique, perspective) drawings using various techniques.	1 Describe the relationship of orthographic projection to multiview drawings. 2 Explain how to develop one and two point perspective drawings. 3 Explain the basic difference in the three types of axonometric projection. 4 Explain the universal systems model applied to drafting processes. 5 Produce multi-view drawings.	**Drafting Principles** -PowerPoint Lesson: The Universal Systems Model - U.S.M. and drafting applications -Analyze drawing types and their functions	Text: **Technology** by Wright pp.224-239 Text: **Technology: Engineering & Design** by Brusic pp.151-161, pp.254 -256, 348	Universal Systems Model Quiz I Drafting Analysis Quiz Multi-view Drawings	15
1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models.	1 Complete a safety exam with 100% accuracy. 2 Use tools and machines safely.	**Machine Safety** -PowerPoint Lesson -Safe use of tools and machines	Teacher created handout sheets	Safety Quiz Evaluation of Lab Activity	5
1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models.	1 Demonstrate proper use and care of tools and facilities. 2 Explain the process of creating a prototype. 3 Construct a prototype from scale drawings.	**Fabrication** -Mechanical Drawing of a prototype - Construct a prototype from an Isometric drawing using appropriate tools and machines	Teacher created handout sheets	Lab Report: Prototyping Evaluation of Prototype Project	10
6.3 Explain how the various components (source, encoder, transmitter, receiver, decoder, destination, storage, and retrieval) and processes of a communication system function.	1 Define Communication Technology. 2 Describe items that are communicated. 3 Identify the components of a communication system. 4 Identify the process of a communication system (universal systems model).	**Using Technology to Communicate** PowerPoint lesson/Worksheet Text reading -Communication in our world -Parts of a communication system -U.S.M. and communication systems -Using Morse Code to send a message activity	Text: **Technology** by Wright pp.362-366 Teacher created handout sheets	Communication Technology Quiz Lab report: Communicating with Morse Code	6

6.1 Explain how information travels through the following media: electrical wire, optical fiber, air, and space.	1 Define Telecommunication 2 Explain the difference between AM and FM. 3 Explain electric current theory. 4 Explain information traveling through a wire. 5 Explain information traveling through the air. 6 Explain analog signals.	**Telecommunication** Text reading and notes PowerPoint Lesson -The physics of telecommunication -Electrical principles -Electromagnetic waves -Hard-wired systems -Broadcast systems	Text: **Technology** by Wright pp.418-424	Telecommunication Quiz	3
7.2 Identify the criteria necessary to select the tools and procedures used in the safe production of products in the manufacturing process, such as material properties, required tolerances, and end-uses.	1 Describe the types of materials and their properties that are inputs to technological systems. 2 Explain the use of Tolerances. 3 Describe and give one example of each type of finishing material in the manufacturing process. 4 Explain the universal systems model applied to manufacturing processes.	**Manufacturing Criteria** Text reading and notes -Types of Materials -Material Properties - Measurement -Tolerances -Finishing Materials	Text: **Technology** by Wright pp. 69-72, 229	Measurement Quiz Materials & Tolerances Quiz Universal Systems Model Quiz II	6
7.3 Describe the advantages of using robotics in the automation of manufacturing processes, such as, increased production, improved quality, and safety.	1 Explain how Robots operate. 2 Describe the advantages of using robotics in the automation of manufacturing processes.	**Automation of Manufacturing Processes** Video: Basic Robotics Text reading and notes -Robotics	Text: **Technology** by Wright pp. 298, 302-303, 312	Robotics Quiz	4
6.2 Differentiate between digital and analog signals. Describe how communication devices employ digital and analog technologies (e.g., computers, cell phones).	1 List the parts of a computer system. 2 List common uses of the internet. 3 Explain digital signals and differentiate from analog.	**Computer and Internet Communication** Text Reading and notes -Computer systems -Networks -The internet; access, domains, world wide web, email, ecommerce -Analog vs. digital Signals	Text: **Technology** by Wright pp.442-457	Communication Devices Quiz	3

6.4 Identify and explain the applications of laser and fiber optic technologies (e.g., telephone systems, cable television, photography). 6.5 Explain the application of electromagnetic signals in fiber optic technologies, including critical angle and total internal reflection.	1 Identify applications of fiber optic technologies. 2 Explain information traveling through a fiber optic cable.	**Fiber Optic Systems** Text reading and notes -Fiber optic networks -Fiber optic cables	Text: **Technology** by Wright pp.361, 426,	Fiber Optics Quiz	2
5.5 Compare and contrast alternating current (AC) and direct current (DC) and give examples of each.	1 Define electric current. 2 Define direct current. 3 Define alternating current. 4 Compare and contrast alternating current and direct current.	**Electrical Power** PowerPoint lesson/Worksheet Text reading -Atomic Structure -Types of current -Types of circuits	Text: **Technology, Engineering & Design** by Brusic, Fales, & Kuetemeyer pp. 216-219	AC/DC Quiz	4
5.2 Identify and explain the components of a circuit including sources, conductors, circuit breakers, fuses, controllers, and loads. Examples of some controllers are switches, relays, diodes, and variable resistors.	1 Explain the components of an electrical circuit. 2 Explain the components of a communication system. 3 Translate a message from and to Morse Code. 4 Understand content-specific vocabulary, terminology, and jargon unique to electrical circuits.	**Designing a Simple Circuit** -Electrical circuits -Stripping wire -Measuring voltage -Connecting the components -Loads -Fuses -Morse Code -A communication System	Text: Electricity and Basic Electronics by Matt, pp. 7-16, 35-71. Teacher created handout sheets	Electricity Fundamentals Quiz Conductors and Insulators Quiz Resistors and Capacitors Quiz	5
5.3 Explain the relationship between voltage, current, and resistance in a simple circuit using Ohm’s law.	1 Identify George Simon Ohm 2 Clearly state Ohm's Law 3 Solve simple circuit mathematical equations using Ohm's Law	Ohm's Law -Internet research -Analyzing circuits with Ohm's Law -Kirkoff's Law	Text: Electricity and Basic Electronics by Matt, pp. 72-83. Teacher created handout sheets	Ohm's Law Quiz	5

5.1 Explain how to measure and calculate voltage, current, resistance, and power consumption in a series circuit and in a parallel circuit. Identify the instruments used to measure voltage, current, power consumption, and resistance. 5.4 Recognize that resistance is affected by external factors, such as temperature.	1 Use a multimeter to accurately measure voltage, current, and resistance. 2 Explain how a residential electric meter calculates power. 3 Accurately measure voltage and current in a parallel circuit. 4 Accurately measure voltage and current in a series circuit. 5 Explain the effect of external factors on resistance.	**Measuring Electrical Circuits** -Measuring Voltage, Current, Resistance, Power Text Readings -Series Circuits -Parallel Circuits -Ohm's Law -Factors affecting resistance	Text: Electricity and Basic Electronics by Matt, pp.84-106. Teacher created handout sheets Text: Electronics	Series Circuits Quiz Parallel Circuits Quiz Lab Report: Measuring Variables in an Electric Circuit	7
2.1 Identify and explain the engineering properties of materials used in structures (e.g., elasticity, plasticity, R value, density, strength), 2.2 Distinguish among tension, compression, shear, and torsion, and explain how they relate to the selection of materials in structures. 2.3 Explain Bernoulli's principle and its effect on structures such as buildings and bridges. 2.4 Calculate the resultant force(s) for a combination of live loads and dead loads.	1 Explain the engineering properties of structural materials. 2 Identify different types of forces on structures. 3 Clearly state Bernoulli's principal. 4 Identify live and dead load. 5 Build a model bridge to meet design specification using computer software.	**Bridge Design** Software Program: West Point Bridge Designer -defining terms from glossary -discussion of materials and their engineering properties -Discussion of design considerations -Computer modeling	Teacher created handout sheet, West Point Bride Designer Manual	Materials 2 Quiz Forces Quiz Bernoulli's Principle Quiz Calculations based on model bridges built by students	10

2.6 Recognize the purposes of zoning laws and building codes in the design and use of structures. 1.3 Produce and analyze multi-view drawings (orthographic projections) and pictorial drawings (isometric, oblique, perspective), using various techniques 1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼" = 1'0", 1 cm = 1 m) 1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models	1 Explain the purpose of blueprints. 2 Explain the purpose of local building codes. 3 Identify factors that affect the construction process such as zoning and set backs.	**Construction and Residential Design** Video: Foundations Video: Deconstruction-Foundation to roof Software Program: Building Homes of Our Own Research and planning a residential structure -blueprint reading -zoning laws -set backs -building codes	Teacher created handout sheet	Construction Vocabulary Quiz I Construction Vocabulary Quiz II Evaluation of House design	10
4.3 Explain how environmental conditions such as wind, solar angle, and temperature influence the design of buildings.	1 Explain site development. 2 Explain how environmental factors influence design of structures. 3 Build a model residential structure using computer software.	**Building a structure** Software Program: Building Homes of Our Own -prepare to build -site preparation -foundation	Teacher created handout sheet	Site Development Quiz Evaluation of House Design	4
1.3 Produce and analyze multi-view drawings (orthographic projections) and pictorial (isometric, oblique, perspective) drawings using various techniques.	1 Create a pictorial drawing of a residential structure	**Google SketchUp** - Demonstration of SketchUp software -using software, draw a residential structure and fit it into a community	Teacher created handout sheet	Evaluation of House Design	4

7.1 Describe the manufacturing processes of casting and molding, forming, separating, conditioning, assembling, and finishing. 2.5 Identify and demonstrate the safe and proper use of common hand tools, power tools, and measurement devices used in construction.	1 Explain the difference between concrete and cement. 2 Explain the process for pouring and curing concrete. 3 Display knowledge of how to mix and form concrete. 4 Analyze data from destructive testing 5 Describe the manufacturing processes of casting and molding, forming, separating, conditioning, assembling, and finishing.	**Processes of Manufacuring** -form work -mixing and poring concrete -stress test concrete -stripping forms -wall framing layout techniques -architectural modeling techniques -landscaping for energy conservation Injection Molding Activity - manufacturing golf tees	Teacher created handout sheet	Manufacturing Quiz Lab Report: Stress Tests Lab Report: Injection Molding Performance evaluation	10
3.1 Explain the basic difference between open fluid systems and closed fluid systems. 3.4 Recognize that the velocity of a liquid moving in a pipe varies inversely with changes in the cross-sectional area of the pipe 3.5 Identify and explain sources of resistance (e.g., 45º elbow, 90º elbow, changes in diameter) for water moving through a pipe.	1 Identify different types of heating 3 Explain the differences in open and closed fluid systems	**Hydraulics Activities** -Hydraulics lab (syringe kits) -PVC pipe lab open and closed systems flow rate measurements Varied resistances	Text: **Technology, Engineering & Design** by Brusic, Fales, & Kuetemeyer pp. 213-216	Fluid Systems Quiz Lab Report: Hydraulics	5
3.2 Explain the differences and similarities between hydraulic and pneumatic systems, and explain how each relates to manufacturing and transportation systems 3.3 Calculate and describe the ability of a hydraulic system to multiply distance, multiply force, and effect directional change.	1 Identify how hydraulics work 2 Identify how pneumatics work 3 Explain the differences in hydraulics and pneumatics	**Text Readings** - Calculating Mechanical Advantage exercises -Types of hydraulic systems	Text: **Technology, Engineering & Design** by Brusic, Fales, & Kuetemeyer pp. 171, 196-200, 213-216	Fluid Systems II Quiz	4

4.4 Identify and explain alternatives to nonrenewable energies, such as wind and solar energy conversion systems. 4.3 Explain how environmental conditions such as wind, solar angle, and temperature influence the design of buildings.	1 Describe the main ways solar energy is converted into mechanical motion 2 Explain the differences between passive and active solar conversion. 3 Describe how wind energy is converted into mechanical motion 4 Describe a common geothermal energy conversion system 5 Explain the operation of a common biomass converter	**Renewable Energy** -Water Energy -Wind Energy -Solar Energy -Geothermal Energy -Ocean Energy -Thermochemical Energy -Biochemical Energy Solar Oven Demonstration	Text: **Technology** by Wright pp. 538-548	Energy Quiz Project Evaluation Performance Evaluation	6
4.1 Differentiate among conduction, convection, and radiation in a thermal system, such as, heating and cooling a house and cooking. 4.2 Give examples of how conduction, convection, and radiation are considered in the selection of materials for buildings and in the design of a heating system.	1 Describe common ways to heat homes and buildings 2 Explain Conduction 3 Explain Convection 4 Explain Radiation	**Text reading** -Thermal systems Heat experiments with house model	Text: **Technology** by Wright pp. 331-332, 550-553	Thermal Systems Quiz Data analysis of house model experiments	6
4.1 Differentiate among conduction, convection, and radiation in a thermal system(e.g. heating and cooling houses , cooking)	Explain the differences between passive and active solar collectors	**Solar Energy** (passive and active collectors) -Student will build a solar energy system. Options include a solar cooker or an active system consisting of a collector, hoses, pump and storage tank.	Text: **Technology** by Wright pp. 526-534 and 538-546	Lab Report: Solar Energy Systems Project Evaluation	10
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Attachment 2

Worcester Public Schools
High School Curriculum

Course Syllabus– Part I

Course Title: Technology/Engineering

Course Description:

Technology/Engineering will introduce students to the world of technology/engineering as a first step to becoming technologically literate citizens. For students the course will open the door to engineering carriers and develop connections between science, mathematics and technology. In this course students will participate in hands on activities that connect directly to real world experiences and see how engineering is connected to every day life in the world. Students will be required to develop cross curricular skills of science, mathematics and literacy that will promote their involvement in the creation and application of technology.

Course Objectives:

Students will:

- Develop a deep and rich understanding of the term technology and the engineering design process.
- Demonstrate the complementary relationship among science mathematics, technology, and engineering.
- Understand how advances in technology affect human society, and how human society determines which new technologies will be developed.

Essential Questions:

1. How are science and engineering related to technology?
2. What is the role of science, technology, and engineering in our lives?
3. How can science and technology/engineering be use to solve community and environmental problems?

Texts:

Museum of Science, Engineering for the Future Curriculum, 2006
Worcester Public Schools, Technology/Engineering Curriculum, WPS 2006

District-Wide Reading Skills Across the Curriculum:

- **Preview** (survey) – note major elements such as organization, vocabulary, summary and graphics.
- **Ask Questions -** question the text, the author and self.
- **Activate Prior Knowledge** (schema) – use what is already known to enhance understanding of what is new in the text.
- **Make Connections -** link text to self, text to world and text to text.
- **Visualize -** use sensory images to create a mental picture of the scene, story, situation, or process and involve oneself in it.
- **Draw Inferences -** go beyond the literal information in the text including predicting, figurative meaning and thematic understanding.
- **Distinguish Key Ideas -** recognize main idea and key concepts.
- **Use Fix-Up Strategies -** monitor own understanding by pausing to think, re-reading, considering, restating what makes sense.

Contextual Vocabulary:

engineering
design process
fluid dynamics
thermodynamics
construction
modeling
electricity
communications

Recommended Grading Policy (indicate percent for each factor):

- Classroom participation -
- Projects/papers -
- Homework -
- Final test/assessment* - 10%
- Annual science research project (research, experiment, record, analyze data, and present results). This project constitutes 25%of the term 3 grade. Students are required to complete one project per year.

*The Worcester School Committee requires that the final test/assessment be 10% of a student's grade

Prerequisite Courses:

None

Note to Teachers: In addition to handing out the above syllabus to students, you should also hand out to them your expectations in the following areas:

- ✓ Homework policy
- ✓ Make-up policy
- ✓ Attendance requirements
- ✓ Any other expectations

Worcester Public Schools
High School Curriculum

Course Syllabus – Part II, Academic Content for the First Semester
Technology/Engineering

Content/Topics	Skills/Understandings	Required Papers/Projects, and Final Assessment/Test	Academic Standards (Worcester Benchmarks and State Frameworks)
Introduction to the design process. Measuring, computing, and planning.	**Demonstrate an understanding of the design process and how to apply it.**	**SAMPLE ASSIGNMENTS:**	**SIS (1-4) Design Process Mathematics Skills (OM.SC.TE.01-08) (OM.SC.TE.46-45)**
The safe and proper use of hand tools.	**Demonstrate the proper handling and proper safety applications of tool use.**	**Students develop posters that demonstrate the safe and proper use of tools and post them in the class.**	**Students will learn the principals of practical problem solving, the research and design process, and the creative tools of innovation and invention. (Technology/Engineering 1.1-1.5) (OM.SC.TE.09-13)**
Engineering design and the principles of practical problem solving.	**Understand the design process and how it relates to community problem solving.**		
Steps of the design process.	**Demonstrate understanding of the process of design.**	**Students develop scaled design diagrams that can be used to develop a model.**	
Design process and the advancement of society.			
Standard visual formats and products of design.	**Use standard visual presentations in preparation for developing design models.**		
Construction of prototypes and modeling.	**Construct prototypes and use them to evaluate the design as a solution for problems.**		
The process of construction technology.	**Demonstrate the process required to construct a building. Demonstrate understanding of**		**Develop understanding of the process required to construct a building such as site**

Site preparation. **Structural engineering design and materials selection.** **Permitting and the construction process.** **Bernoulli's principle and its effect on buildings and bridges.** **Calculate forces on building components.** **The purpose of building codes and zoning laws in the design process** **Demonstrate safety on the works site.** **Hydraulic and pneumatic systems.** **Open and closed fluid systems.**	**the principles of sight preparation.** **Demonstrate understanding of the materials used in constructing a structure** **Demonstrate understanding of the permit and construction process.** **Apply Bernoulli's principle to bridge and building construction.** **Determine the forces present on building components.** **Draw connections between community planning, environmental considerations and the application of zoning regulations and building codes.** **Understand and apply the safe use of tools and materials in the workplace.** **Demonstrate a knowledge and understanding of the similarities between hydraulic and pneumatic systems.** **Compare and contrast open pneumatic systems and closed fluid systems.**		**preparation, foundation development, erecting the structure, utilities installation, and site finishing.** **Scale or full size modeling should be used in this unit. (Technology/Engineering 2.1-2.6) (OM.SC.T14-19)** **Develop an understanding of fluid and gas systems that allow force to be transferred, transfer**

The velocity of liquid flow varies inversely with the area of a pipe cross- section. **The resistance to water flow in a pipe.**	**Be able to explain liquid flow velocity in a pipe cross-section.** **Diagram and explain the resistance to the flow of water in a pipe.**		**water gas,** **oil and removal of waste.** **Demonstrate the application of the engineering process in solving fluid system problems and design. Explain the similarities between hydraulic and pneumatic systems. (Technology/Engineering 3.1-1.5) (OM.SC.TE.20-25)**

Worcester Public Schools
High School Curriculum

Course Syllabus – Part II, Academic Content for the Second Semester
Technology/Engineering

Content/Topics –	Skills/Understandings	Required Papers/Projects, and Final Assessment/Test	Academic Standards (Worcester Benchmarks and State Frameworks)
Student Portfolio Development	**Develop a presentation to be use in the portfolio.**	**SAMPLE ASSIGNMENTS:**	**Annual Inquiry Project**
Engineering activities and energy transfer in thermal systems.	**Demonstrate an understanding of energy transfer through the design of energy distribution systems.**	**Diagram a heating and cooling system for a classroom.**	**Understand the transfer of energy through convection, conduction and radiation. Engage in the application of theses means of energy transfer in the engineering of thermal systems. (Technology/Engineering 4.1-4.4) (OM.SC.TE.26-31)**
Conduction, convection, and radiation.	**Explain the differences between conduction, convection, and radiation.**		
Connections between heat transfer and materials used in system design.	**Diagram and explain how heat is distributed through a heating and cooling system.**		
Environment influences and building design	**Communicate how the environment influences building design.**	**Develop a design for a renewable energy generating plant for our community.**	
Identify and explain renewable and non renewable energy resources.	**Provide examples and explain the functional processes of renewable and nonrenewable**		

	energy resources.		
Understand and apply the generation, transmission and application of electrical energy systems.	**Demonstrate understanding of the structure and function of electrical energy systems.**		**Learn the basic concepts of electrical generation and power distribution. Apply the engineering process to solve problems and meet challenges in electrical systems. (Technology/Engineering 5.1-5.5) (OM.SC.TE.32-37)**
Measure and calculate voltage, resistance, current and power in series and parallel circuits.	**Demonstrate using diagrams and mathematically the flow of electricity in series and parallel circuits.**		
Identify and explain components of electrical circuits such as conductors, controllers, and safety systems.	**Use schematic diagrams to build electrical circuits and demonstrate the function of components.**		
Ohm's law.	**Demonstrate the application of Ohm's Law.**		
Alternating and direct current examples of their applications.	**Describe direct and alternating current. Provide multiple examples of the application of both.**		
Communication through diversified symbolic representations.	**Use symbolic representations to develop the circuits of an electrical system.**		
Transmission of information through media (wire, optic fiber, air, and space).	**Explain how information is transferred through diverse media.**		**Develop understandings of the processes and systems that lead to the exchange of information including symbols, measurements, icons, and**
Differentiate between analog	**Explain and use analog and**		

and digital transmissions and their applications.	**digital communication applications.**		**graphic images. Demonstrate the ability to apply the design process to the challenge of communications technology. (Technology/Engineering 6.1-6.9) (OM.SC.TE.38-42)**
The function of components in communication systems.	**Demonstrate, identify, and explain the function of communication system components.**		
The function and application of laser fiber optic technology.	**Explain the application and function of laser fiber optic technologies.**		
The function of electromagnetics in fiber optic technology.	**Explain the application of electromagnetic signals in fiber optic systems.**		
The manufacturing processes of casting, molding, forming, separating, conditioning, assembling and finishing.	**Describe, explain and apply the manufacturing processes.**		**Learn six manufacturing processes and apply the design process to manufacturing problems. (Technology/Engineering 7.1-7.2) (OM.SC.TE.43-45)**
Criteria necessary to select tools, develop safety procedures, select materials, and develop standards for product use and application.	**Identify and develop criteria necessary for tool selection, safety in manufacturing, materials selection and end use of products.**		
Robotics use in the automation of manufacturing.	**Describe the advantages of using robotics in manufacturing.**		

Attachment III

Resources for Technology/Engineering teachers

- Technology/Engineering Curricula, provided by teachers, available as files to read and/or download- e.g. Masstec Curriculum Resource Page, http://www.masstec.org/lists.html

- Videos on projects or general teaching- To show "what we do"

- Teachers' websites from across the state or across the nation. Used with permission/acknowledgement, e.g.:

    - Jonathan Dietz for Weston Public Schools- Grade 7 Structures course: http://www.weston.org/schools/ms/MCAS/DesCon7.htm
    - Charlie Corley for Winchester Public Schools: http://mail.winchester.k12.ma.us/~ccorley/
    - Melrose Middle School Technology Education: http://www.melroseschools.com/mms/tech_ed/

- Professional organizations for Technology/Engineering and Science teachers, e.g.

    - MassTEC http://www.masstec.org/

    - Technology Education Association of Massachusetts (TEAM) http://www.awrsd.org/team/

- Specific curriculum resources/publishers:

    - Engineering the Future program at the Museum of Science http://www.mos.org/etf/

    - Hacker, Burghardt, Learning By Design (Prentice Hall),

    - Challenges in Physical Science, Kendall-Hunt Publishing Company, engineering/physical science curriculum from Harvard/Smithsonian Astrophysical Observatory, http://www.kendallhunt.com/index.cfm?PID=219&PGI=152

    - Salvadori Center -Structural engineering education: http://www.salvadori.org/

    - Lego Engineering, http://www.legoengineering.com/

    - MIT Open CourseWare , Highlights for High School, http://ocw.mit.edu/OcwWeb/hs/home/home/index.htm

- PBS Teacher's Domain- Engineering; http://www.teachersdomain.org/sci/engin/
- PBS *Design Squad*- Resources for Educators: http://pbskids.org/designsquad/
- Wind With Miller- Windpower Engineering, http://www.windpower.org/en/kids/index.htm
- Building Big (PBS)- Civil Engineering, http://www.pbs.org/wgbh/buildingbig/
- West Point Bridge Designer- Structural Engineering Simulation, http://bridgecontest.usma.edu/
- Google Sketch-Up -Freeware CAD program, http://www.sketchup.com/

- Engineering Education organizations:
  - The engineering education "wing" of the National Science Digital Library (NSDL). www.engineeringpathway.com
  - American Society for Engineering Education, http://www.asee.org/
  - ITEA Standards for Technological Literacy, http://www.iteaconnect.org/TAA/Publications/TAA_Publications