

BIOTECHNOLOGY II

JULY 2011

COURSE NUMBER TEC 612

TEACHER: MR. DANIEL MULLER

PRINCIPAL: MR. GREG YOUNGMAN

DIRECTOR OF CURRICULUM AND INSTRUCTION: SCOTT RIPLEY

SUPERINTENDENT: DR. JOHN HANNUM

(To be offered beginning 2011-2012 school year)

Level of Course: Academic
Prerequisites: Biotechnology I
Grades Levels Offered to: 10 through 12
Course Number: TEC 612
Number of Credits: 5
Length: Thirty Six Week curriculum / 180 days
Recommended class size: Maximum 19- (*Based upon current Computer restrictions*)
Teacher Recommendation: One-Certified Technology Education Teacher

Purpose:

Students enrolled in Biotechnology II will develop an understanding of biotechnology systems, processes, tools, and materials. In addition, the ethical and environmental implications will be explored. Individual and group experiences are designed to enable students to understand, use, manage, and assess historical, current, and emerging biotechnology developments.

Biotechnology deals with designing and manipulating organisms to create new products and processes for medical, agricultural, and engineering applications. Humans have been using and manipulating organisms for thousands of years, but advances of the last twenty years have significantly changed the field. Areas that will be covered are:

Bio-processing (Fermentation & use of Alternative Fuels) Students will design and develop a bioreactor that will continuously produce ethanol.

Medical Immunology (Insulin Production) Students will design, model and present systems which would produce insulin.

Environment Bio-restoration (Phytoremediation) Students will design a system that will remove lead from one quarter acre brown field which was previously a chemical storage facility.

Biochemistry Enzymology Students are to participate in a competition to develop an environmentally friendly household cleaner that is effective in the following areas of the home: Kitchen, Laundry, and Bathroom

Method of Instruction:

Biotechnology in the technology education classroom can be accomplished using a variety of instructional strategies that effectively deliver content and engage students in real world problems. Activities will be presented and will demonstrate a blend of behavioral, cognitive, and constructivist learning theories. An instructor will direct student learning by establishing classroom conditions: the context of the activity, the student task, the expected outcomes, and the resources and information available to the student. The activities will utilize instructional strategies that promote constructivist learning environments-meaningful contexts, collaboration, unique solutions, and thoughtful reflection. This combined behavioral, cognitive, and constructivist approach to teaching biotechnology will provide a structure and strategy that reflect the instructional philosophy and traditional approach to content within the technology education profession.

General Objectives:

At the conclusion of this course, the students will be able to:

1. Define biotechnology and technology.
2. Describe biotechnology and technology as a system.
3. List, describe, and implement the steps in the design process.
4. Identify how different systems operate.
5. Utilize a variety of different forms of presentation techniques.
6. Work in teams for learning, problem solving, design and presentation.
7. Prepare for life-long learning by using self-management and self-assessment strategies in terms of knowledge and skills.
8. Develop careful and precise writing.
9. Explore career-specific areas.
10. Develop skills in critical thinking, analytical reasoning and logic, and the ability to establish and recognize the validity of information.
11. Understand the complex relationship of scientific, technological, social, business, legal, historical, and artistic issues in design.
12. Carry out engineering/design/problem solving projects by using established scientific principles in the creation of functional and appealing products.
13. Become an independent leader, recognize when to follow, and know how to be a good team member.
14. Develop and apply cross-disciplinary cognitive knowledge to new problems.

Lecture/Discussion	Objectives 1, 2, 4
Class Projects/ Lab Sessions	Objectives 3, 6, 7, 12, 13, 14
Problem-Based learning	Objectives 4, 8, 10, 11, 15
Computer-Base instruction	Objectives 5
Homework	Objectives 4
Mentor/Visitations	Objectives 9

Measurement of success in meeting these general objectives will be carried out through the following methods of assessment:

Classwork/Homework	Objective 4, 15
Quizzes/Tests Mid Term Exam and Final Exam	Objectives 1, 2
Projects/Labs	Objectives 3, 5, 6, 8, 9, 12, 14, 15
Class Participation	Objectives 7, 10, 11, 13, 15
Quantified by credit points on projects and labs	

Standards Targeted Throughout the Curriculum

New Jersey Core Curriculum Content Standards and Cumulative Progress Indicators

Technology Standards

- Standard 8.1, Educational Technology, is aligned to the International Society for Technology in Education (ISTE) standards and the Partnership for the 21st Century Skills framework.
- Standard 8.2, Technology Education, Engineering, and Design and is aligned with the goals of the International Technology Education Association (ITEA) and the Partnership for 21st Century Skills framework.

21st-Century Life and Careers

Standard 9.1 21st-Century Life and Career Skills:

<http://www.njcccs.org/Standardsearchresult.aspx?contentarea=9&StandardCodes=9.1&StartGrade=5&EndGrade=13&WCSRequest=Y>

All students will demonstrate the creative, critical thinking, collaboration, and problem-solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Standard 9.1 describes skills that prepare students to fully engage in civic and work life. The standard includes six strands, which reflect the Framework for 21st Century Learning:

- Critical Thinking and Problem Solving
- Creativity and Innovation
- Collaboration, Teamwork, and Leadership
- Cross-Cultural Understanding and Interpersonal Communication
- Communication and Media Fluency
- Accountability, Productivity, and Ethics

Standard 9.4 Career and Technical Education:

<http://www.njcccs.org/Standardsearchresult.aspx?contentarea=9&StandardCodes=9.4&StartGrade=5&EndGrade=13&WCSRequest=Y>

All students who complete a career and technical education program will acquire academic and technical skills for careers in emerging and established professions that lead to technical skill proficiency, credentials, certificates, licenses, and/or degrees.

Standard 9.4 describes knowledge and skills that prepare students for postsecondary education, training, and employment in a chosen career pathway. Unlike standards 9.1, 9.2, and 9.3, which apply to all students from grades K-12, standard 9.4 applies only to high school students enrolled in career and technical education programs.

Source: New Jersey Department of Education Standards <http://www.nj.gov/njded/stass/>

New Jersey Technology Education Standards (NJTEA)

- Apply values and make rational decisions about technological issues. (NJTES 1.19)
- Design and make devices and hybrid systems that solve complex real world problems. (NJTES 2.22)
- Develop alternative plans for redesigning devices and systems. (NSTES 2.23)
- Utilize and modify existing devices and systems for use in the solution of new problems. (NJTES 3.16)
- Combine different materials in the production of products. (NJTES 3.19)
- Create computer simulations to test and explain design concepts. (NJTES 4.14)
- Create multimedia presentations to inform others about design concepts, products, and events. (NJTES 4.16)
- Access and search the Internet for relevant information while conducting research. (NJTES 6.16)
- Use advanced publication methods. (NJTES 7.38)
- Generate original ideas based on previous knowledge and research. (NJTES 7.41)
- Acquire knowledge and skills that increase aesthetic awareness as it applies to technological design and ergonomics. (NJTES 7.139)

Source: 1996 Technology Educators Association of New Jersey. (www.TEANJ.org)

Standards of Technological Literacy from the (TFAA) Technology for All Americans Project and the International Technology Education Association (ITEA)

- In order to comprehend the scope of technology, students should learn that technology is closely linked to creativity, which has resulted in innovation. (TFAA #1, H)
- In order to recognize the core concepts of technology, students should learn that systems thinking involves considering how every part relates to others. (TFAA #2, N)
- In order to comprehend the attributes of design, students should learn that are trade offs that are made in the design process. (TFAA #8, F)
- In order to comprehend the attributes of design, students should learn that the requirements for a design are made up of criteria and constraints. (TFAA#8, G)
- As part of learning how to apply design processes, students should be able to make two-dimensional and three-dimensional representations of the designed solution. (TFAA #11, J)
- In order to select, use, and understand information and communication technologies, students should learn that the use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas. (TFAA #17, K)

Source: International Technology Education Association (2000). Standards for Technological Literacy. Reston, VA: ITEA. ISBN 1-887101-02-0

Benchmarks of Project 2061

- Almost all control systems have inputs, outputs, and feedback. The essence of control is comparing information about what is happening to what people want to happen, and then making appropriate adjustments. This procedure requires sensing information, processing it, and making changes. In almost all modern machines, microprocessors serve as centers of performance control.
- Technological problems often create a demand for new scientific knowledge, and new technologies make it possible for scientists to extend their research in new ways or to undertake entirely new lines of research. The very availability of new technology itself often sparks scientific advances.
- Mathematics, creativity, logic and originality are all needed to improve technology.
- Technology usually affects society more directly than science because it solves practical problems and serves human needs (and may create new problems and needs). In contrast, science affects

society mainly by stimulating and satisfying people's curiosity and occasionally by enlarging or challenging their views of what the world is like.

- Social and economic forces strongly influence which technologies will be developed and used. Which will prevail is affected by many factors, such as personal values, consumer acceptance, patent laws, and the availability of risk capital, the federal budget, local and national regulations, media attention, economic competition, and tax incentives.
- Technological knowledge is not always as freely shared as scientific knowledge unrelated to technology. Some scientists and engineers are comfortable working in situations in which some secrecy is required, but others prefer not to do so. It is generally regarded as a matter of individual choice and ethics, not one of professional ethics.
- In deciding on proposals to introduce new technologies or to curtail existing ones, some key questions arise concerning alternatives, risks, costs, and benefits. What alternative ways are there to achieve the same ends, and how do the alternatives compare to the plan being put forward? Who benefits and who suffers? What are the financial and social costs, do they change over time, and who bears them? What are the risks associated with using (or not using) the new technology, how serious are they, and who is in jeopardy? What human, material, and energy resources will be needed to build, install, operate, maintain, and replace the new technology, and where will they come from? How will the new technology and its waste products be disposed of and at what costs?
- Human inventiveness has brought new risks as well as improvements to human existence.

Source: *Science For All Americans Project 2061 1990, Oxford Press, ISBN 0-19-506770-3*
<http://www.project2061.org/tools/benchol/bolframe.htm>

Engineering activities will also stress many New Jersey and National math and science standards. Math and science applications are imperative to help solve problem solving and engineering/design activities.

Specific Behavioral Objectives and Timelines:

Current school structure: One day = One 42 minute period. Many units of study are woven together to simulate the real world.

Unit 1: Course Introduction and Safety Guidelines

Time: 3 days/Ongoing

Goal:

- To introduce the students to the course expectations, discipline policy, and safety guidelines.

Objectives:

Students will be able to:

- Understand the course expectations and timeline for instruction.
- Understand the discipline policy that relates to behavior in this class.
- Outline the specific safety guidelines of the classroom and shop rules.

Assignments:

- Movie related worksheet

Lab Activities:

- None

Audio-Visual Needs:

- Overhead projector
- Movie "UVEX PPE Eyewear Training Video/Technology Department Eye Safety"

Computer Needs/Use: None

- N/A

Assessment Method:

- Safety Quiz

Standards targeted via this unit:

- 8.1
- 8.2
- 9.1
- 9.3
- 9.4

Unit #2: Student Expectations and Personal Relevance

Time: 1 week

Goal:

- To assist the students in developing this program of study so it appeals to their intellect and emotions.

Objectives:

Students will be able to:

- Use the Baldrige or similar process to assist with finding ways the program can be personally relevant.
- To define a metric against which efforts are to be assessed. Proper implementation will result in well-defined goals with clear markers of progress in those goals. This will also give the team the freedom to decide these measures and to help further team cohesion.
- Use the Baldrige or similar process as a way of improving their leadership and management skills.

Assignments:

- This activity will help to establish future lab activities.

Lab Activities:

- Participate in the “Baldrige in the classroom” process.

Audio-Visual Needs:

- None

Computer Needs/Use:

- None

Assessment:

- Authentic: Teacher observation

Standards targeted via this unit:

CCWRS- 1,3,4

Note- The Malcolm Baldrige program focuses on achievements and improvements in seven areas: leadership, strategic planning, customer and market focus, information and analysis, human resource focus, process management and business results. <http://www.quality.nist.gov/>

Unit #3: Team-Work/Performance

Time: 1 day/On Going

Goal:

- To have students understand and demonstrate the importance of good teamwork skills.

Objectives:

Students will be able to:

- Demonstrate effective skills for interaction with others
- Demonstrate the ability to work with people who are different from oneself
- Demonstrate a positive attitude about self
- Demonstrate skills in responding to criticism and providing constructive criticism to others
- Demonstrate an understanding of the importance of personal skills and attitudes towards job success
- Demonstrate positive work attitudes and behaviors

Assignments:

- Group engineering and design projects

Lab Activities:

- Team success model
- Guest Speakers

- Visitations to work sites

Audio-Visual Needs:

- None

Computer Needs/Use:

- None

Assessment:

- Authentic: Teacher observation
- Traditional: none/ class participation

Standards targeted via this unit:

- 8.1
- 8.2
- 9.1
- 9.3
- 9.4

Unit #4: Tool and Machine Safety

Time: 1 Week/Ongoing

Goal:

- To introduce students to the safe and proper operation of hand tools and power machines so that they may fabricate solutions to engineering problems. In the process of using these tools, the student will view automation and operator safety as significant engineering problems to brainstorm as well as the effect of gender or hand dominance on operations.

Objectives:

Students will be able to:

- Safely operate a band saw, scroll saw, drill press, disk and belt sander, brake, metal roller, shear, soldering gun, hand drill, etc.
- Safely use hand tools- claw hammer, screw driver, hand saw, coping saw, hack saw
- Read a metric and English ruler.

Assignments:

- Tool and Machine Safety

Lab Activities:

- Safety Demonstrations/ Safety Rules

Audio-Visual Needs:

- None

Computer Needs/Use:

- None

Assessment:

- Traditional: Safety Tests

Standards targeted via this unit:

- 8.1
- 8.2
- 9.1
- 9.3
- 9.4

Unit #5: BIOPROCESSING

Time: 4-6 Weeks/Ongoing

Goal:

- Technological- To gain and understanding of industrial bio-processing systems involving bioreactors
- Biological- to gain a working understanding of biological requirements necessary in alternative fuels production

Objectives:

Students will be able to:

- Demonstrate the application of microbes in bio-processing.
- Apply technology, science, and mathematics to the task of designing and constructing the necessary technological system
- Use of basic tools and materials to make a prototype of the system.

Assignments:

- Bio-processing Fermentation/ Alternative Fuels

Lab Activities:

- Safety Demonstrations/ Safety Rules

Audio-Visual Needs:

- Smartboard

Computer Needs/Use:

- Student Internet research
- Documentation development
- Word/Publisher
- Digital Camera
- Student presentation using Smartboard
- Computer lab
- Word-processing, data base, spreadsheet, internet, & presentation software

Assessment:

- Authentic: Comprehensive documentation, teacher observation, teamwork performance, student self and group assessment, daily logs, project based.
- Traditional: Class participation

Standards targeted via this unit:

- 5.1
- 5.2
- 5.3
- 8.1
- 8.2
- 9.1
- 9.3
- 9.4

Unit #6: MEDICAL

Time: 3-4 weeks/Ongoing/Interwoven

Goal:

- Technological- To gain and understanding of technological systems requirements associated with the use of bacteria and gene splicing techniques in the production of insulin.
- Biological- Develop and understanding of bacteria, their ability through DNA techniques to produce insulin appropriate for human use, and the conditions necessary for their survival.

Objectives:

Students will be able to:

- List 2 reasons why the use of bacteria to produce insulin is necessary and advantageous.
- Identify an appropriate organism for the manufacture of insulin.
- Design a model to aid in the demonstration and explanation of how insulin gene is recombined in plasmid of E.Coli for insulin production.
- Outline environmental conditions necessary to maintain bacteria growth for production of insulin.

Assignments:

- Medicine/ Insulin production immunology

Lab Activities:

- Safety Demonstrations/ Safety Rules

Audio-Visual Needs:

- Smartboard

Computer Needs/Use:

- Student Internet research
- Documentation development
- Word/Publisher
- Digital Camera
- Student presentation using Smartboard
- Computer lab
- Word-processing, data base, spreadsheet, internet, & presentation software

Assessment:

- Authentic: Comprehensive documentation, teacher observation, teamwork performance, student self and group assessment, daily logs, project based.
- Traditional: Class participation

Standards targeted via this unit:

- 5.1
- 5.2
- 5.3
- 8.1
- 8.2
- 9.1
- 9.3
- 9.4

Unit #7: Higher Education and Careers (Life after formal schooling)

Time: 1-2 weeks

Goal:

- To allow the student time to examine higher education requirements for a variety of career possibilities.
- To demonstrate the importance of mathematical and scientific knowledge and skills.
- To allow students to realize the differences of salaries based on fields and versus courses taken (BS, MS, PhD & licenses PE, Professor of Engineering).
- To allow the student to understand there are many engineering fields.

Objectives:

Students will be able to:

- Identify institutes of higher education with engineering degree programs.
- Identify the many career opportunities an engineering degree supports. Vision of their daily life.
- Identify throughout the course the roll of mathematics and scientific knowledge/skills.
- Identify what produce a larger income.
- Identify careers where engineering thinking would play a vital role.

Assignments:

- Research higher education institutes and scholarships for women
- Research careers in engineering
- Use math and scientific knowledge/skills to solve an engineering design problem.
- Current research on career salaries
- Research women friendly employees of engineers
- Create a resume during this course.

Lab Activities:

- Guest Speakers/Visitation
- Field of Engineering Power Point Presentation
- Discuss Co-op options and company internships
- Bridges career research software
- Discuss daily life with guest speakers: What is their daily life like? Work indoors, outdoors; travel, Office work, Visit customers, Team work or alone, Specialists, paper and computer or physical work with equipment.

Audio-Visual Needs:

- VCR/Tapes- Engineering Fields

Computer Needs/Use:

- Internet, Computers, Presentation Software, Projector

Assessment Method:

- Authentic: Documentation/Presentation
- Traditional: Essay, Teacher observation

Standards targeted via this unit:

- NJCCCS WRS 1

Assessment:

The assessment of student progress in the objectives cited on the previous pages will be primarily by, but not limited to, the following criteria.

Design Portfolios & Presentations	40%
Homework	10%
Tests	15%
Class Participation/Code of Conduct	15%
Knowledge Logs/Notebooks	10%
Engineering Mentor Communication	10%

Homework, Extra Credit Policy:

Due to the periodic nature of homework in this course, homework will not be accepted late unless a legitimate excuse exists. Extra credit will be available during the design and problem solving activities in the form of additional research/development and competitive events.

Special Course Policies:

Success in this course will be based on a variety of factors, however the instructor will most directly assess the student's performance in comprehensive design and problem solving activities, teamwork performance, and class participation as the means of determining a grade. A typical week in class will consist of formal instruction on a variety of material, students working in groups to complete work pertaining to the lecture, research and development, teamwork to generate possible solutions to and solve problems, and in some cases the development of different products and prototypes. Quizzes and tests will be given to re-emphasize and assess the student's understanding of the presented information.

Periodic evaluation of objectives and this curriculum guide:

Labs: Supporting materials will be developed for all labs to help the new teacher.

- Inventor Parametric 3-D design software

Lab/Classroom set up and special needs:

The recommended maximum class size is eighteen students. This course will be taught implementing a variety of different and state of the art instructional technologies such as:

- Multiple computers- One computer for every student.
- Scanner
- Digital camera
- Multiple workbenches
- SmartBoard technology
- Projection screen and device
- Electrical outlets
- Testing area- Structure Tester
- Teamwork areas
- GIS software
- Table top: scroll saw, drill press, band saw, sander
- Hand tools
- Software: word processing, presentation, electronic workbench, internet digital camera, scanner, publishing, spreadsheet, Pro-DESK TOP or Inventor Parametric 3-D design software,
- Movie “What’s Up In Technology”-
 - Produced by Thirteen-WNET - Ed. Resource Center-450 W. 33rd. Street NY, NY 1001
- Movie “Exploring the Design Process”-#V710-1994 Hearlihy & Co.

Unit #7: ENVIRONMENT

Time: 5-6 Week/Ongoing

Goal:

- Technological- A working understanding of environmental remediation technology systems involving plants.
- Biological- A working understanding of phytoremediation requirements necessary in environmental bioremediation processes

Objectives:

Students will be able to:

- Identify several plants that remove lead from soil
- Select plants for the used o problem variables
- Determine the growth requirements for plants selected
- Cite a clear definitions of a phytoremediation system
- Identify 4 applications of phytoremediation currently used in the US
- Recognize the biotechnical problems surrounding the design of phytoremediation system
- Collect information and brainstorm solutions to there problems
- Produce a model of one possible system
- Evaluate the system
- Explain system solutions to others

Assignments:

- Environment/ Phoytoremediation system

Lab Activities:

- Safety Demonstrations/ Safety Rules

Audio-Visual Needs:

- Smartboard

Computer Needs/Use:

- Student Internet research
- Documentation development
- Word/Publisher

- Digital Camera
- Student presentation using Smartboard
- Computer lab
- Word-processing, data base, spreadsheet, internet, & presentation software

Assessment:

- Authentic: Comprehensive documentation, teacher observation, teamwork performance, student self and group assessment, daily logs, project based.
- Traditional: Class participation

Standards targeted via this unit:

- 5.1
- 5.2
- 5.3
- 8.1
- 8.2
- 9.1
- 9.3
- 9.4

Unit #8: BIOCHEMISTRY

Time: 6-7 weeks

Goal:

- Technological- To have an understanding of industrial and domestic (household) application of enzymes and enzyme technology, especially that of detergents and cleaning agents
- Biological- To have an understanding of the various properties of enzymes and the role of enzymes play in certain catalytic processes

Objectives:

Students will be able to:

- Explain the characters and functions of enzymes
- Explain the catalyzation process
- Cite examples of the use of enzymes in industry
- Explain and demonstrate how enzymes are used in making detergents and cleaning products
- Discuss the effects of industrial enzyme use upon the environment

Assignments:

- Environment/ Phoytoremediation system

Lab Activities:

- Safety Demonstrations/ Safety Rules

Audio-Visual Needs:

- Smartboard

Computer Needs/Use:

- Student Internet research
- Documentation development
- Word/Publisher
- Digital Camera
- Student presentation using Smartboard
- Computer lab
- Word-processing, data base, spreadsheet, internet, & presentation software

Assessment:

- Authentic: Comprehensive documentation, teacher observation, teamwork performance, student self and group assessment, daily logs, project based.
- Traditional: Class participation

Standards targeted via this unit:

- 5.1
- 5.2
- 5.3
- 8.1
- 8.2
- 9.1
- 9.3
- 9.4

Homework, Extra Credit Policy:

Due to the periodic nature of homework in this course, homework will not be accepted late unless a legitimate excuse exists. Extra credit will be available during the design and problem solving activities in the form of additional research/development and competitive events.

Special Course Policies:

Success in this course will be based on a variety of factors, however the instructor will most directly assess the student's performance in comprehensive design and problem solving activities, teamwork performance, and class participation as the means of determining a grade. A typical week in class will consist of formal instruction on a variety of material, students working in groups to complete work pertaining to the lecture, research and development, teamwork to generate possible solutions to and solve problems, and in some cases the development of different products and prototypes. Quizzes and tests will be given to re-emphasize and assess the student's understanding of the presented information.

Labs: Supporting materials will be developed for all labs to help the new teacher.

- Baldrige Process
- Engineering Design Activities
- Invention and Innovation Product Design
- Area of Engineering
- Publication- Famous Women Engineers
- Power Point Presentation- Biotechnology
- History of Biotechnology -Power Point
- Spreadsheet Analysis of design)graphing Calculator/CPU
- Word-processing
- Smart board Technology
- Publishing
- Inventor Parametric 3-D design software

Lab/Classroom set up and special needs:

The recommended maximum class size is eighteen students. This course will be taught implementing a variety of different and state of the art instructional technologies such as:

- Multiple computers- One computer for every student.
- Scanner
- Digital camera
- Multiple workbenches

- SmartBoard technology
- Projection screen and device
- Electrical outlets
- Testing area- Structure Tester
- Teamwork areas
- Table top: scroll saw, drill press, band saw, sander
- Hand tools
- Software: word processing, presentation, electronic workbench, internet digital camera, scanner, publishing, spreadsheet, Pro-DESK TOP or Inventor Parametric 3-D design software,
- Movie “What’s Up In Technology”-
 - Produced by Thirteen-WNET - Ed. Resource Center-450 W. 33rd. Street NY, NY 1001
- Movie “Exploring The Design Process”-#V710-1994 Hearlihy & Co.

Note: A current technology education lab would be suitable. School budget is used to currently fund this program. Federal Perkins funding could be used if there is an Engineering CIP coded program. This class would be considered a 1st level course. Students would then enter our Engineering Design Technology 2 and 3 programs. Gender equity funding may be another source of funding.

Supplementary Readings and Instructors Bibliography:

- Hutchinson, John Design and Problem Solving in Technology. (Delmar, Albany, New York). 1994. ISBN 0-8273-5244-1.
- Norman, Eddie, Advanced Design and Technology Second Addition. (Pearson Education Limited, Essex, England). 1995. ISDN 0 582 24496 4
- Smith, Howard. Understanding Technology. (Goodheart-Wilcox Company, Tinley Park, Illinois). 1998. ISBN 1-56637-374-3.
- Todd, Ronald. Introduction to Design and Technology. (Thompson Learning Tools, Cincinnati, Ohio). 1996. ISBN 0-538-64465-6
- Wright, Thomas. Technology Systems. (Goodheart-Wilcox Company, Tinley Park, Illinois). 1966. ISBN1-56637-263-1.
- The Existential Pleasures of Engineering by Samuel Florman
- INVENTING AMERICA: A History of the United States was published in 2002 by *W. W. Norton & Co.*

Web pages that support learning:

- <http://www.ieee.org> Institute of Electrical and Electronics Engineers, Inc.
- <http://www.energy.gov> Energy web pages
- <http://www.nasa.gov> NASA Web Page
- www.dot.gov US Department of Transportation
- <http://attila.stevens-tech.edu/lore-el/pre-college/> Stevens Institute of Technology
- <http://www.njtea.org> NJ professional teachers association for technology education
- <http://www.iteawww.org> National professional teachers association for technology education
- <http://www.fsea.org> After school club
- <http://www.swe.org/SWE/StudentServices/CareerGuidance/ForStudents/UsefulWebsites.html>
- <http://www.quality.nist.gov> Baldrige National Quality Program
- <http://www.epa.gov/tio/download/citizens/bioremediation.pdf> EPA website
- <http://bioremediationgroup.org/> Group discussion on bioremediation
- <http://www.asee.org> American Society of Engineering Education

- <http://engr.oregonstate.edu/pubs/docs/CoE-AR-2002.pdf>
- <http://www.biodiesel.org/> National Biodiesel board
- <http://www.nae.edu/> National Academy of Engineering
- <http://www.siemens-foundation.org/> Siemens Foundation
- <http://www.jets.org/> Junior Engineering Technical Society
- <http://www.discoverengineering.org/home.asp> Discover Engineering On Line
- http://www.inventionatplay.org/playhouse_main.html Lemeison Center for the Study of Invention & Innovation
- <http://www.engineeringk12.org/> ASEE Engineering k-12 education web page

College Search Sites:

- <http://encarta.msn.com/college/collegeFind.asp>
- <http://www.petersons.com/ugchannel/?ppcse=looksmart>
- <http://www.gocollege.com/>
- <http://www.usnews.com/usnews/edu/college/cohome.htm>
- <http://www.aesmentor.org/>
- <http://www.search4careercolleges.com/?affiliateid=603>