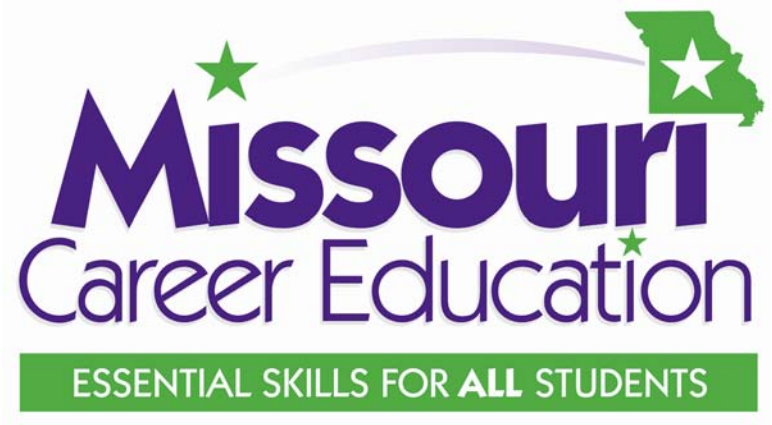

Missouri Center for Career Education
Department of Career & Technology Education
Central Missouri State University
Warrensburg, Missouri

Division of Career Education
Department of Elementary & Secondary Education
Jefferson City, Missouri

Exploring Careers in Science, Technology, Engineering & Mathematics

Exploring Career Clusters

Course A

Architecture & Construction
Science, Technology, Engineering, and Mathematics
Manufacturing

Science, Technology, Engineering, and Mathematics Student Competencies

The following competencies selected for this unit were taken directly from the Career Cluster Resources for Science, Technology, Engineering, and Mathematics (www.Careerclusters.org).

Cluster Knowledge and Skills

Demonstrate effective oral, written, and visual communication.

Use information technology to gather, store, apply and communicate data.

Apply safety practices in your environment.

Develop a brand awareness of safety, health, and environment hazards.

Participate effectively on a team.

Understand how and when to form teams.

Know current ethical and legal standards in the scientific and mathematics as well as the engineering and technology community.

Identify patterns, relations, and functions of an organization or a workplace.

Research career pathways in science, technology, engineering, and mathematics.

Pathway Knowledge and Skills

Apply concepts and processes as defined by the National Council of Teachers of Mathematics in Principles and Standards for School Mathematics.

Apply concepts and processes as defined by the National Research Council in the National Science Education Standards and by the American Association for the Advancement of Science in Benchmarks for Science Literacy.

Apply concepts and processes as defined in the Standards for Technological Literacy: Content for the Study of Technology.

Use information technology applications.

Apply technical content concepts, and principles.

Model technical competence.

Examine elements of the design process.

Demonstrate and apply the process design.

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Division of Career Education
Department of Elementary & Secondary Education
Jefferson City, Missouri

Introducing the Science, Technology, Engineering & Mathematics Cluster

Exploring Career Clusters

Course A

Architecture & Construction

Science, Technology, Engineering, and Mathematics

Manufacturing

Introducing the Science, Technology, Engineering & Mathematics Cluster

The cluster of careers found in *"Science, Technology, Engineering & Mathematics"* encompasses planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services. This career cluster can be divided into two distinct Pathways of *Engineering and Technology* and *Science and Math*.

Each Pathway has distinct knowledge and skill requirements as well as shared common knowledge and skill requirements. Students who understand these relationships will be prepared and able to make informed career decisions. Students should be given the opportunity to explore and investigate not only the traditional career options of *engineer* and *engineering technologist* but should be encouraged to touch on the many other related occupations found in this Career Cluster (See *Science, Technology, Engineering & Mathematics Cluster Pathways* chart in this section).

Teacher Preparation

The suggested scenario for this unit is the design of a Footbridge for a specific location. You should review the whole project and decide on any alterations you want to make to the scenario. You have the option to make part of or all of the project a simulation or a "real life" activity. That is, you may have your students construct a footbridge on your campus or at a park. You may also choose to use a scenario of your own design. If so, you need to include as many occupations as time permits.

Introduce the unit with a short activity which helps students quickly grasp the breadth and depth of this Career Cluster. Be sure to have every student engaged so they can begin the unit of study with the big picture of this career cluster.

Prepare a bulletin board display that illustrates the two Pathways (*Engineering & Technology and Science & Mathematics*) found in the *Science, Technology, Engineering & Mathematics Cluster*. Be sure to include photos/illustrations of non-typical careers such as *packaging engineer, power systems engineer, research technician*, and/or *technical writer*. List under each category some of the key skills and knowledge needed. Remember, the use of bulletin boards, web searches, posters, and engaged projects will assist students in learning about and participating in various career experiences.

Reference: "Science, Technology, Engineering & Mathematics Career Pathways", *"Career Cluster Resources for* Science, Technology, Engineering & Mathematics, *National Association of State Directors of Career Technical Education Consortium"* (www.Careerclusters.org)

Pathways:

- Engineering & Technology
- Science & Mathematics

Handout: *Science, Technology, Engineering & Mathematics Career Cluster Pathways* chart
This handout is for teacher reference for the student activity, "Pathway Matching Activity." It should not be given to students until after the completion of this activity.

Suggested Activities

Introduction to the Cluster

Chose one of the following activities or design an appropriate activity that will allow students to comprehend the wide array of occupations involved in their built world.

1. *How Many Jobs?*
   Use a Power Point presentation or photos & drawings to show a bridge, highway, and/or high-rise building during various stages of design and construction and an exhaustive list of jobs and have students or teams of students match the job titles to the photos.

2. *What's in a Refinery?*
   Using a Power Point presentation or photos of a petroleum refinery, have students or teams of students identify as many jobs (careers) involved in designing, constructing, and operating/maintaining the refinery.

3. *"From Raw Material to Product on the Shelf"*
   Using a Power Point presentation or photos of products being produced in a manufacturing plant, have students or teams of students select from a list the jobs that would be involved in changing raw materials into finished products.

Upon completion of the activity, discuss with students the various occupations needed to plan and manage through scientific research and professional and technical services. Be sure to point out occupations that are not obvious.

Pathway Matching
Have students match (even if they have to guess) random list of occupations to the two Career Pathways found in the *Science, Technology, Engineering & Mathematics Cluster*. Discuss with students what makes up each Pathway (See *Pathway Matching* activity). This activity is designed to help students focus on the vast occupational opportunities available to them in this Career Cluster. It is not important at this point in the course that they are able to recognize most of these occupations. It is important that they begin to see their possibilities. Discuss with students the differences between the three Career Pathways without listing the various occupations. Use the following activity or design an appropriate activity that will allow students to comprehend the wide array of occupations involved in their built world. You should review the list and become familiar with the occupations listed. (www.collegeboard.com/csearch/majors_careers/profiles/ and www.stepfour.com/jobs)

Exploring Careers in Science, Technology, Engineering & Mathematics

Student Name: _____ANSWER KEY_____
(PRINT)

Date Assignment Due: _____ **Date Assignment Submitted**: _____

_____ **Activity Satisfactorily Completed** _____ **Activity Not Completed (see notes below)**

Pathway Matching

This activity should not be "scored" for right or wrong answers. The intent is to expose students to the very wide array of occupational options they have in this Career Cluster. "Scoring" should be based on the student's effort in completing the assignment. You, the teacher, should be actively involved with this activity and use it as an appropriate segue into class discussion about occupational opportunities.

The *Science, Technology, Engineering & Mathematics Career Cluster* is divided into two Pathways according to the tasks of planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services and research and development services. Our built environment requires the services of *scientists, technologists, engineers* and *mathematicians*. Our built environment includes all the manufactured products we use as well as food processed for eating and medicines processed for health concerns. All of these begin with design and end with the need for maintenance. However, without the involvement of the careers in this cluster, the quality, the quantity and the safety of these products would be severely limited.

The two Pathways for the *Science, Technology, Engineering and Mathematics Career Cluster* are:

1. Engineering and Technology
2. Science and Math

Occupation – Pathway Matching

Given the list below, place the number of the pathway from the above list next to the occupation it matches. If you think an occupation could match with more than one of the pathways, you may put more than one number. Be ready to say why you think the occupation matches the pathway or pathways you listed.

__1__ **Aerospace Engineer**	__1__ **Quality Technician**
__2__ **Analytical Chemist**	__1__ **Agricultural Technician**

__1__ **Licensing Engineer**	__1__ **Technical Sales Manager**
__1__ **Zoologist**	__2__ **Materials Analyst**
__1__ **Network Technician**	__1__ **Project Manager**
__1__ **Packaging Engineer**	__1__ **Materials Engineer**
__2__ **Numerical Analyst**	__1/2__ **Technical Writer**
__1__ **Aeronautical Engineer**	__2__ **Geneticist**
__2__ **Radio Chemist**	__1__ **Drafter**
__1__ **Electrical Engineer**	__1__ **Hazardous Waste Engineer**
__2__ **Microbial Physiologist**	__2__ **Protozoologist**
__1__ **Civil Engineer**	__1__ **Ocean Engineer**
__1/2__ **Computer Programmer**	__2__ **Protein Scientist**
__1__ **Mechanical Engineer**	__1__ **Textile Engineer**
__1__ **Transportation Engineer**	__2__ **Marine Scientist**
__2__ **Materials Scientist**	__1__ **Energy Transmission Engineer**
__1__ **Facilities Technician**	__2__ **Research Technician**
__2__ **Science Teacher**	__1__ **Environmental Engineer**
__1__ **Agricultural Engineer**	__1__ **Construction Engineer**
__1__ **Engineering Consultant**	__1__ **Survey Technician**

__2__ **Biologist**	__1__ **Fire Protection Engineer**
__2__ **Physicist**	__1__ **Radio/TV Broadcast Technician**
__2__ **Demographer**	__1__ **Electronics Technician**
__2__ **Ecologist**	__1__ **Hazardous Waste Technician**
__1__ **Computer Engineer**	__1__ **Naval Engineer**
__2__ **Nutritionist**	__2__ **Oceanographer**
__1__ **Pharmaceutical Engineer**	__1__ **Plastics Engineer**
__2__ **Quality-Control Scientist**	__2__ **Geologist**
__1__ **Mining Engineer**	__2__ **Nuclear Chemist**
__2__ **Applied Mathematician**	__1__ **Computer Science Technician**
__1__ **Communications Engineer**	__2__ **Expert Systems Scientist**
__1/2__ **CAD Operator**	__2__ **Spectroscopist**
__1__ **Petroleum Engineer**	__1__ **Operations Research Engineer**
__2__ **Herpetologist**	__1__ **Telecommunications Engineer**
__2__ **Meteorologist**	__2__ **Cartographer**
__2__ **Chemist**	__2__ **Communications Technologist**
__2__ **Technologist**	__2__ **Toxicologist**
__1__ **Radiology Engineer**	__1__ **Industrial Engineer**

__1__Manufacturing Processes Engineer	__2__Dye Chemist
__2__ Environmental Scientist	__1__Materials Lab & Supply Technician
__2__Geophysicist	__2__Atmospheric Scientist
__1__Packaging Technician	__1__Nuclear Engineer
__2__Inorganic Chemist	__2__Laboratory Technician
__2__Mammalogist	__1__Industrial Engineering Technician
__1__Electrician	__2__Research Chemist
__2__Statistician	__1__Biomedical Engineer
__2__Scientific Visualization/Graphics Expert	__2__Ornithologist
__1__Chemical Engineer	__2__Organic Chemist
__2__Hydrologist	__1__Manufacturing Technician
__2__Economist	__1__Sound Technician
__1__Systems Design Engineer	__1__Quality Engineer
__2__Paleontologist	__1__Automotive Engineer
__1__Software Engineer	__1__Project Engineer
__2__Polymer Scientist	__2__Nuclear Technician
__1__Development Engineer	__1__Application Engineer
__1__Structural Engineer	__2__Cosmologist
__2__Nanobilogist	__1__Metallurgic Engineer

__1__**Product Design Engineer**	__1__**Marine Engineer**
__2__**Mathematician**	__1__**Power Systems Engineer**
__2__**Electronmicroscopist**	__1__**Computer Hardware Engineer**
__1__**Architectural Engineer**	__2__**Mycologist**
__1__**Researcher**	__2__**Ichthyologist**
__1__**Safety Engineer**	__1__**Computer Software Engineer**
__2__**Archeologist**	__2__**Cryptographer**
__1__**Biotechnology Engineer**	__1__**Prototype Engineer**
__2__**Astronomer**	__1__**Manufacturing Engineer**
__2__**Astrophysicist**	__1__**Human Factors Engineer**
__2__**Conservation Scientist**	__2__**Geoscientist**
__2__**Botanist**	__2__**Crystallographer**
__1__**Geothermal Engineer**	

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Exploring Careers in Science, Technology, Engineering & Mathematics

Student Name:

(PRINT)

Date Assignment Due: **Date Assignment Submitted**:

☐ **Activity Satisfactorily Completed** ☐ **Activity Not Completed (see notes below)**

Pathway Matching

The *Science, Technology, Engineering & Mathematics Career Cluster* is divided into two Pathways according to the tasks of planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services and research and development services. Our built environment requires the services of *scientists, technologists, engineers* and *mathematicians*. Our built environment includes all the manufactured products we use as well as food processed for eating and medicines processed for health concerns. All of these begin with design and end with the need for maintenance. However, without the involvement of the careers in this cluster, the quality, the quantity and the safety of these products would be severely limited.

The two Pathways for the *Science, Technology, Engineering and Mathematics Career Cluster* are:

1. _____
2. _____

Occupation – Pathway Matching

Given the list below, place the number of the pathway from the above list next to the occupation it matches. If you think an occupation could match with more than one of the pathways, you may put more than one number. Be ready to say why you think the occupation matches the pathway or pathways you listed.

_____ **Aerospace Engineer**	_____ **Quality Technician**
_____ **Analytical Chemist**	_____ **Agricultural Technician**
_____ **Licensing Engineer**	_____ **Technical Sales Manager**
_____ **Zoologist**	_____ **Materials Analyst**

_____ **Network Technician**	_____ **Project Manager**
_____ **Packaging Engineer**	_____ **Materials Engineer**
_____ **Numerical Analyst**	_____ **Technical Writer**
_____ **Aeronautical Engineer**	_____ **Geneticist**
_____ **Radio Chemist**	_____ **Drafter**
_____ **Electrical Engineer**	_____ **Hazardous Waste Engineer**
_____ **Microbial Physiologist**	_____ **Protozoologist**
_____ **Civil Engineer**	_____ **Ocean Engineer**
_____ **Computer Programmer**	_____ **Protein Scientist**
_____ **Mechanical Engineer**	_____ **Textile Engineer**
_____ **Transportation Engineer**	_____ **Marine Scientist**
_____ **Materials Scientist**	_____ **Energy Transmission Engineer**
_____ **Facilities Technician**	_____ **Research Technician**
_____ **Science Teacher**	_____ **Environmental Engineer**
_____ **Agricultural Engineer**	_____ **Construction Engineer**
_____ **Engineering Consultant**	_____ **Survey Technician**
_____ **Biologist**	_____ **Fire Protection Engineer**

_____ **Physicist**	_____ **Radio/TV Broadcast Technician**
_____ **Demographer**	_____ **Electronics Technician**
_____ **Ecologist**	_____ **Hazardous Waste Technician**
_____ **Computer Engineer**	_____ **Naval Engineer**
_____ **Nutritionist**	_____ **Oceanographer**
_____ **Pharmaceutical Engineer**	_____ **Plastics Engineer**
_____ **Quality-Control Scientist**	_____ **Geologist**
_____ **Mining Engineer**	_____ **Nuclear Chemist**
_____ **Applied Mathematician**	_____ **Computer Science Technician**
_____ **Communications Engineer**	_____ **Expert Systems Scientist**
_____ **CAD Operator**	_____ **Spectroscopist**
_____ **Petroleum Engineer**	_____ **Operations Research Engineer**
_____ **Herpetologist**	_____ **Telecommunications Engineer**
_____ **Meteorologist**	_____ **Cartographer**
_____ **Chemist**	_____ **Communications Technologist**
_____ **Technologist**	_____ **Toxicologist**
_____ **Radiology Engineer**	_____ **Industrial Engineer**

_____ **Manufacturing Processes Engineer**	_____ **Dye Chemist**
_____ **Environmental Scientist**	_____ **Materials Lab & Supply Technician**
_____ **Geophysicist**	_____ **Atmospheric Scientist**
_____ **Packaging Technician**	_____ **Nuclear Engineer**
_____ **Inorganic Chemist**	_____ **Laboratory Technician**
_____ **Mammalogist**	_____ **Industrial Engineering Technician**
_____ **Electrician**	_____ **Research Chemist**
_____ **Statistician**	_____ **Biomedical Engineer**
_____ **Scientific Visualization/Graphics Expert**	_____ **Ornithologist**
_____**Chemical Engineer**	_____**Organic Chemist**
_____**Hydrologist**	_____**Manufacturing Technician**
_____**Economist**	_____**Sound Technician**
_____**Systems Design Engineer**	_____**Quality Engineer**
_____**Paleontologist**	_____**Automotive Engineer**
_____**Software Engineer**	_____**Project Engineer**
_____**Polymer Scientist**	_____**Nuclear Technician**
_____**Development Engineer**	_____**Application Engineer**
_____**Structural Engineer**	_____**Cosmologist**

_____**Nanobiologist**	_____**Metallurgic Engineer**
_____**Product Design Engineer**	_____**Marine Engineer**
_____**Mathematician**	_____**Power Systems Engineer**
_____**Electronmicroscopist**	_____**Computer Hardware Engineer**
_____**Architectural Engineer**	_____**Mycologist**
_____**Researcher**	_____**Ichthyologist**
_____**Safety Engineer**	_____**Computer Software Engineer**
_____**Archeologist**	_____**Cryptographer**
_____**Biotechnology Engineer**	_____**Prototype Engineer**
_____**Astronomer**	_____**Manufacturing Engineer**
_____**Astrophysicist**	_____**Human Factors Engineer**
_____**Conservation Scientist**	_____**Geoscientist**
_____**Botanist**	_____**Crystallographer**
_____**Geothermal Engineer**	

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Planning, managing, and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.

Sample Career Specialties / Occupations	Aerospace Engineer* Aeronautical Engineer* Agricultural Engineer* Agricultural Technician* Application Engineer* Architectural Engineer* Automotive Engineer* Biomedical Engineer* Biotechnology Engineer* Chemical Engineer* Civil Engineer* Communications Engineer* Computer Engineer* Computer Hardware Engineer* Computer Programmer* Computer Science Technician* Computer Software Engineer* Construction Engineer* Consultant* Development Engineer* Drafter* Electrical Engineer* Electrician* Electronics Technician* Energy Transmission Engineer* Environmental Engineer* Facilities Technician* Fire Protection Engineer* Geothermal Engineer* Hazardous Waste Engineer* Hazardous Waste Technician* Human Factors Engineer * Industrial Engineer* Industrial Engineering Technician* Licensing Engineer* Manufacturing Engineer* Manufacturing Technician* Manufacturing Processes Engineer* Marine Engineer* Materials Engineer* Materials Lab & Supply Technician* Mechanical Engineer* Metallurgic Engineer* Mining Engineer* Naval Engineer* Network Technician* Nuclear Engineer* Ocean Engineer* Operations Research Engineer* Packaging Engineer* Packaging Technician* Petroleum Engineer* Pharmaceutical Engineer* Plastics Engineer* Power Systems Engineer* Product Design Engineer* Project Engineer* Project manager* Prototype Engineer* Quality Engineer* Quality Technician* Radio/TV Broadcast Technician* Radiology Engineer* Researcher* Safety Engineer* Software Engineer* Sound Technician* Structural Engineer* Survey Technician* Systems Design Engineer* Technical Sales Manager* Technical Writer* Telecommunications Engineer* Textile Engineer* Transportation Engineer*	Analytical Chemist* Anthropologist* Applied mathematician* Archeologist* Astronomer* Astrophysicist* Atmospheric scientist* Biologist* Botanist* CAD operator* Cartographer* Chemist* Communications technologist* Conservation scientist* Cosmologist* Cryptographer* Crystallographer* Demographer* Dye chemist* Ecologist* Economist* Electronmicroscopist * Environmental scientist* Expert systems scientist* Geneticist* Geologist* Geophysicist* Geoscientist* Herpetologist* Hydrologist* Ichthyologist* Inorganic chemist* Laboratory Technician * Mammalogist* Marine scientist* Materials analyst* Materials scientist* Mathematician * Mathematics* Metallurgist* Meteorologist* Microbial Physiologist* Mycologist* Nanobiologist* Nuclear chemists* Nuclear technician* Numerical analyst* Nutritionist* Oceanographer* Organic chemist* Ornithologist* Paleontologist* Physicist* Polymer scientist* Programmer* Protein scientist* Protozoologist* Quality-control scientist* Radio chemist* Research chemist* Research Technician* Science Teacher * Lab Technician* Scientific visualization / graphics expert* Spectroscopist* Statistician* Technical writer* Technologist* Toxicologist* Zoologist*
Pathways	**Engineering and Technology**	**Science and Math**
Cluster K&S	**Cluster knowledge and skills** ♦Academic Foundations ♦Communications ♦Problem Solving and Critical Thinking ♦Information Technology Applications ♦ Systems ♦ Safety, Health and Environment ♦Leadership and Teamwork ♦Ethics and Legal Responsibilities ♦Employability and Career Development ♦Technical Skills	

Career Exploration

Students should begin this unit by getting a broad overview of the types of occupations they will find in this Career Cluster. They need to see the big picture first before exploring individual occupations.

Teacher Preparation

Identify enough occupations so you will have no more than two or three students working at any one station. Set up stations around your classroom/lab with short activities that represent the two Pathways of occupations which are *Engineering and Technology* and *Science and Math*. Be sure to include occupations such as *Petroleum Engineer*, *Hazardous Waste Engineer* or *Metallurgist*, as well as typical occupations such as *Civil Engineer* or *Materials Scientist.*

Suggested Activities

Round-Table Explorations Activity

Have students rotate through each station. (See *Round-Table Explorations* activity) On this worksheet, have the students select the level of education/training and basic skills **they think** they would need to successfully work in that occupation (Area Career Center, Community College, and/or University). Students will research specific career occupations later in the unit of study. (Print enough *Round Table Exploration Information* sheets and *Worksheets* for each student)

Round-Table Exploring Examples

Mining Engineer – Set up an area that displays an open pit mine. Have students identify the various tasks that are required to extract and process materials from the mine. You may even have them calculate the volume of material hauled from the bottom of the mine to the processing point.

Conservation Scientist – Set up an area that displays grasslands and/or forest where the state wants to build a highway. Have the students describe what problems this might cause the grasslands and/or forest. Have the students make suggestions on how to protect these lands with the highway in place.

Teacher: Class Discussion

Discuss various academic and career preparation requirements for each of the stations explored by the students. Help students understand the differences between each educational level and occupational level of Technician, Technologist, and Professional. (See *Round-Table Exploration Information* sheet in this section and *Definitions of Three Levels of Occupations* sheet in Career Search section)

Round Table Explorations Information

Every occupation requires a minimum amount of training and/or education and certain basic skills. As you rotate through each of the Occupation Stations, you will be asked to match the education and the skills **you think** are needed to enter that occupation.

Education: Different levels of education/training are required for different occupations. Below is a list with a brief description of each level. Use these definitions to determine the level needed for each occupation you examine.

REQUIRED EDUCATION LEVELS

No Schooling – not completing high school or dropping out at an age allowed by law

High School GEP (General Education Program) – graduating from high school with a general education or college preparatory program

High School CEP (Career Education Program/Area Career Center) – graduating from high school with a program in one of the career education occupations

On-the-Job Training/Apprenticeship – learning a job while you are working in that job (may or may not require a high school diploma)

Trade School – school that teaches specialized skills for specific occupations (can be public schools, private schools, or trade unions)

Military Training – similar to trade schools in that you are taught specialized skills for a specific occupation in the military (requires a minimum of a high school diploma)

Community College (2-year) – two-year college education that leads to an associate's degree and may include specialized technical skills

College/University (4-year) – four-year college education that leads to a bachelor's degree and may include higher levels of specialized technical skills, engineering, science, and mathematics on a professional level

College/University (graduate degree) – education after a bachelor's degree in professional fields such as engineering, science, medicine, law, management or education

REQUIRED SKILLS

Reading

Ability to read and comprehend at a high school level

Writing

Ability to write simple and complex sentences with correct spelling, grammar and punctuation which allows for clear communication

Calculating

Ability to perform simple mathematical operations such as add, subtract, multiply and divide and comprehend simple geometric relationships (this may include reading and measuring with a ruler or tape measure)

Computer Literacy

Ability to perform basic computer operations such as save and retrieve files, word processing and spreadsheet operations

Problem-Solving/Critical Thinking

Ability to clearly identify and solve problems through a defined process

Leadership/Teamwork

Ability to successfully lead a group and work with a group to accomplish a task or solve a problem

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Round Table Explorations

Student Name:

(Print)

Date Assignment Due: **Date Assignment Submitted**:

☐ **Activity Satisfactorily Completed** ☐ **Activity Not Completed (see notes below)**

Fill in the required spaces below after you have completed the activity for each station.

OCCUPATION:

Print the Name of the Occupation

Check (√) the minimum level of education you think would be needed for entry to this occupation:

☐ No School ☐ High School (GEP) ☐ High School (CEP)

☐ On-the-Job Training ☐ Trade School ☐ Military Training

☐ Community College (2 years) ☐ College/University (4 years)

☐ College/University (Graduate Degree)

Check (√) all the required skills you think would be needed for entry to this occupation:

☐ Reading ☐ Writing ☐ Calculating

☐ Computer Literacy ☐ Problem Solving/Critical Thinking

☐ Leadership/Teamwork

SEE BACK OF THIS PAGE FOR REFLECTIVE RESPONSES

Reflective Response:

Use complete sentences, correct spelling and correct punctuation when completing the statements below. Be sure to read what you write to make sure it is clear to you and others.

1. I think this occupation would be fun to work in because

OR

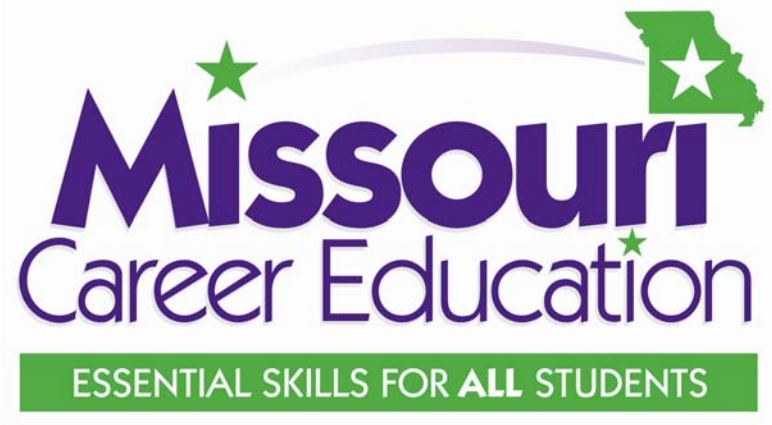
1. I do not think this occupation would be fun to work in because

2. An example of how I might use problem solving in this occupation

3. An example of how I might have to use teamwork in this occupation

4. The reasons I checked as the minimum level of education needed for this occupation is

5. The reasons I checked these skills needed for this occupation are



Missouri Center for Career Education
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Department of Elementary & Secondary Education
Jefferson City, Missouri

Introducing the Science, Technology, Engineering & Mathematics Cluster

Exploring Career Clusters

Course A

Architecture & Construction

Science, Technology, Engineering, and Mathematics

Manufacturing

Engineering & Technology

Our built environment includes everything designed and created by humans from natural and synthetic materials. The clothes we wear, the transportation systems that move us and our goods, the structures we live in, the tools we use to design and build, the processed packaged foods we eat and the toys we play with require science, technology, engineering and mathematics (STEM) in various ways and in varying degrees. All of these begin as an idea, a thought that must be processed. This process can be informal, but in most cases will be a formal design process. Sciences and mathematics explain our natural world and give us laws to follow when designing. Engineering allows us to apply that knowledge to find real solutions and technology enables us to produce those solutions.

The components of product design, no matter what the product, are *function*, *form*, *environmental impact*, and the *ease of use*. David Ringholz, Industrial Designers Society of America (IDSA) member and assistant professor of Industrial Design at Georgia Tech University, suggests a mnemonic of M.A.S.H.; Mechanics, Aesthetics, Sustainability, and Human Factors to frame these components of design. (Ringholz, 2005)

Mechanics concentrates on the structure and function of a product. That is, how well does the product perform as well as what materials the product is made of? Mechanics also refer to the production processes used to construct and/or assemble the product. *Aesthetics* refers to the form and appearance of the product. How appealing is it to the user? Does the form and appearance lend to a safe and enjoyable experience when using the product? Often the *elements and principles of design* must be followed when dealing with aesthetics. *Sustainability* of a product can have a positive or negative impact on the environment. How long will the product last? Are the parts recyclable? Is there a way to reduce the number of parts and still function well? How much energy is required to make or operate the product? Finally, *Human Factors* require close scrutiny of the interaction of the product with humans, sometimes referred to as "ergonomics." (Ringholz, 2005)

Teacher Preparation

Prepare a bulletin board or other visual display that illustrates scientific and mathematical processes, engineering design processes, and technological processes which produce the products we use everyday. Be sure to provide a mixture of gender and ethnicity in your displays.

The suggested scenario for this career cluster is the research, design and presentation of a proposed *footbridge* for a local park. You should review the whole project and decide on any alterations you want to make to the scenario. You have the option to make part of or all of the project a simulation or a "real life" experience. You may choose to use a scenario of your own design. If you do, you need to be sure and include as many occupations as time permits. West Point Bridge Designer is a very good software program that can be downloaded for free (http://bridgecontest.usma.edu/). Although the program has been created to design vehicle bridges, your students will gain appropriate knowledge about the bridge design process and have fun. There are numerous resources on the web for bridge design, including footbridge design.

Suggested Activities

Footbridge Design

This scenario will include the following segments:

1. Meeting with City/County Parks & Recreation Department (Client)
2. Establish client criteria for Footbridge design
3. Complete Bridge Design Proposal Contract
4. Complete an Environmental Impact Study (abbreviated)
   View site(s) (This may be simulated through photos or arrange a field trip)
   - You may want to provide more than one site for comparison
   - Survey site(s) (simple topographical survey to produce map)
   - Write description of park area in regard to vegetation and habitats
   - Map traffic patterns for walking and vehicle traffic
5. Design Footbridge
6. Construct model (you may choose to construct actual bridge if time permits)
7. Prepare formal presentation to Parks & Recreation Commission
8. Present design proposal(s) to Commission

Reference:

Ringholz, David, (2005). Design Optimization Through M.A.S.H. Analysis. *The Technology Teacher*, 64(8), 9-11

END OF DOCUMENT

Possible Careers: Civil Engineer ▪ Survey Technician ▪ Transportation Engineer ▪ Ecologist ▪ Environmental Scientist ▪ CAD Operator ▪ Drafter Research Technician

The Engineering Design Process

Footbridge Engineers, Inc. has been asked by the local Parks and Recreation Commission (PRC) to develop a proposal for a footbridge on a site to be determined by Footbridge Engineering in the local park. The proposal must be presented in a formal written form to the Commission and include the following:

1. Environmental Impact Study (EIS)
    - Topographical map of site location to include:
        - Contour lines
        - Foot and vehicle traffic patterns
        - Description of vegetation
        - Waterways with high and low water marks
        - Photos of footbridge site
    - Impact on vegetation and/or animal habitats
2. Footbridge Design Drawings
    - Orthographic views with basic dimensions
    - Mathematical calculations for weight loads
3. Scaled model of footbridge

The Parks and Recreation Commission require each design team to make a maximum 10 minute formal presentation to the Commission on their design proposal. The presentation must include the following:

1. Copy of EIS
2. Graphic display of Footbridge Design Drawings and Scale Model (photos and/or second scale model)
3. Electronic graphic presentation of the process the design team went through (e.g. Power Point, Flash)

Once you have been assigned to a design team, you and your team must organize and assign tasks to each team member. Follow the directions from your teacher for design tasks.

Learning Objectives:

Upon successful completion of this activity, you will be able to:

1. Explain the importance of engineering in the design process.
2. Explain the importance for and use of an environmental impact study.
3. Identify the basic components found on a contour topographic map.
4. Organize materials into a formal presentation.
5. Describe the steps taken to design a simple bridge.

To successfully complete this activity, follow the tasks listed below:

Background Information:

1. Review information about environmental impact studies (EIS) provided by your teacher (See *Environmental Impact Study Information* Sheet)
2. Review information about surveying and topographic maps (See *Surveying and Topographic Maps Information* Sheet)
3. Review information about designing bridges provided by your instructor (See *Bridge Design Concepts Information* Sheet)

Design Team Tasks:

1. Meet with Parks & Recreation Commission (PRC) to determine design criteria (See *Bridge Design Criteria* form)
2. Complete Bridge Design Proposal Contract
3. Conduct topographic survey of possible sites (See *Survey Data* Sheet)
4. Complete Environmental Impact Study (EIS) (See *EIS* Form)
5. Design footbridge using established criteria (See *Bridge Design Criteria* form)
6. Complete footbridge orthographic drawings (See *Brainstorming Bridge Design Ideas* assignment)
7. Select best bridge idea.
8. Construct footbridge model for destructive testing (be sure to take close-up photos of your bridge before you test it)
9. Create graphic display for static display (See *Footbridge Proposal Presentation* assignment)
10. Create electronic presentation for formal presentation to the PRC(See *Footbridge Proposal Presentation* assignment)

END OF DOCUMENT

Student Name: **Client Meeting Date**:

Print

Assessment Score:

Bridge Design Criteria

The engineer is hired by a *client* (a person that needs a structure or product designed to meet specific requirements) to engineer/design a structure or product. The client will often have some idea of what they want in their design but will need the professional engineer to develop the best plans for their product. The engineer will begin by interviewing the client to gain an understanding of what the client wants and needs. This activity will give you an experience finding out what the client wants and needs for this design project.

Bridge Design Criteria

Client Name: ,

Print Name Company Name

Possible Locations of Bridge Site:

Use of Bridge:

☐ **People/Large Animals**	☐ **Vehicles Only**	☐ **People/Large Animals/ Vehicles**
☐ **One-Way Traffic**	☐ **Off Road Only**	☐ **Off Road Only**
☐ **Two-Way Traffic**	☐ **Auto Traffic**	☐ **Auto Traffic**
	☐ **Non-Motorized**	☐ **Non-Motorized**
	☐ **Horse-Powered**	☐ **Horse-Powered**

☐ **Other**

Maximum Width of Bridge:

Safety Concerns:

Maximum Height of Road Bed from Ground:

Hand Rails: ☐ **Yes** ☐ **No**

Maximum Live Load:

Preferred Bridge Material:

☐ **Steel** ☐ **Aluminum** ☐ **Heavy Timber** ☐ **Dimensioned Lumber**

Bridge Style Preference: ☐ **Beam** ☐ **Truss** ☐ **Suspension** ☐ **Cable-Stay** ☐ **Cantilever** ☐ **Arch**

Possible Careers: Civil Engineer ▪ Survey Technician ▪ Transportation Engineer ▪ Ecologist ▪ Environmental Scientist ▪ CAD Operator Drafter ▪ Research Technician

Bridge Design Proposal Contract

This Contract made and entered into this _____day of _____, 20_____,

between _____,
Print Name

called Client whose address is _____,
Street Address City State Zip Code

and Student Design Company, Inc., called Designer, whose address is

_____
Class Hour/Period School Name

Both parties hereby agree:

1. Client will provide criteria for the design of the footbridge.

2. Designer will provide preliminary designs for Client to choose and approve.

3. PAYMENT: Client agrees to pay Designer a maximum total _____ points. Designer agrees that Client has the option to reduce said total points based on quality and completeness of project. Point variation will be based on attached Scoring Guide (provided by Owner). Any additional points must be agreed to in writing by both parties in a timely manner. Final payment will be made upon completion of formal presentation and approval Client.

4. COMPLETION: Designer shall begin design work immediately upon obtaining signed contract and shall complete project no later than _____, subject to permissible delays as described in School Student Handbook and/or Instructor Regulations.

5. Designer shall perform all work and shall not pass on or relegate work to any sub-contractor (student or other person) inside or outside of class.

6. TOOLS & EQUIPMENT: Designer shall be responsible for the safe and correct use of all tools and/or equipment used by Designer to complete the project.

7. DESIGN MATERIALS & SUPPLIES: Designer shall be responsible for requesting and obtaining all necessary materials and supplies for the project.

8. SAFETY: Designer shall be responsible for knowing and following all general and specific safety rules while working on the project. Designer shall keep work area clear of all clutter and/or hazards at all times during the project.

9. Client agrees to select three possible locations for construction of the selected bridge design.

Design Criteria:

_____
_____
_____
_____
_____
_____
_____
_____
_____

_____ _____
Client Signature Designer Signature

_____ _____
Print Name Print Name

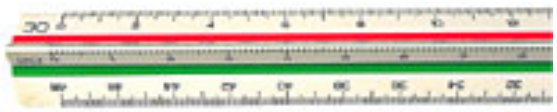
Possible Careers: Biomedical Engineer ▪ Biotechnology Engineer ▪ Computer Programmer ▪ Consultant ▪ Researcher ▪ Survey Technician ▪ Technical Writer ▪ Biologist ▪ Botanist ▪ CAD Operator ▪ Cartographer ▪ Conservation Scientist ▪ Ecologist ▪ Environmental Scientist ▪ Herpetologist ▪ Hydrologist ▪ Ichthyologist ▪ Laboratory Technician ▪ Organic Chemist ▪ Mycologist ▪ Ornithologist ▪ Statistician

Topographic Map & Surveying Information

Topographic (top·o·graph·ic) maps are drawings showing the *contour* (surface) of the earth in a specific area or region. Topographic maps are often referred to as *topos* by engineers. Topos are drawn by *cartographers* (map makers) or drafters using information (a given distance above or below a known reference point) from a *survey*. A survey is the collection of elevation points over a specific land area using surveying equipment and information gathered by observation such as the type of vegetation found in the area.

Contours are imaginary lines on a map that join points of the same elevation on the surface of the land above or below a reference point, such as sea level. After locating (plotting) all points on the map, lines are drawn to connect each point with the same elevation value. Once this is completed, you will have the beginnings of a topographic map. There are also other features placed on the topo map.

Features found on a topo map other than contour lines are such things as the name, size and location of trees; the name and location of ponds, lakes, streams (wet or dry), and rivers; the location of buildings and other structures; and walkways, streets and trails. In addition to these features, a North direction symbol, along with the *scale* of the map and who drew the map are also included. All of these features are indicated by symbols. A *legend* is often included to explain each of the symbols. There is an example of a topographic map showing some of these features on the next page.



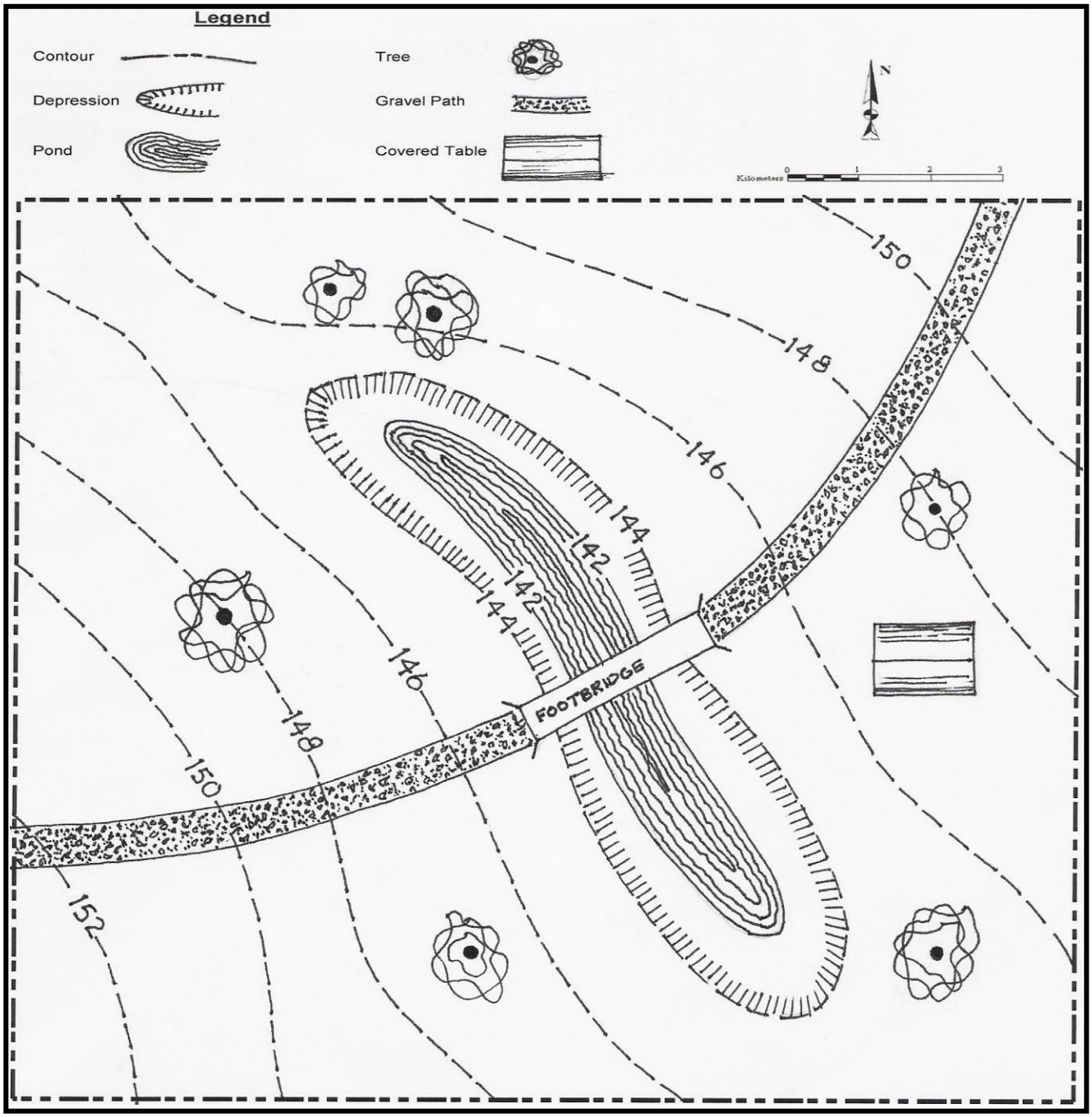
Surveying is the process of locating *boundaries* of a tract of land by marking the corners of the tract and measuring the distance and direction of each boundary. Surveys are also used to determine the elevations of the surface of a tract of land. Surveys allow the accurate placement of buildings and other structures on a tract. With accurate surveys, landowners can identify exactly where their property lines are located.

Surveys are conducted by licensed surveyors who are trained to use sophisticated equipment to take *measurements* for boundaries. Measurements are identified by two elements, *distance* and *direction* (e.g., 120.5’ 30° 30’ SE). This is known as the *Polar Coordinate* system. The tools used to measure

these distances and directions are a *Transit* or a *Theodolite*. A third tool, the *Builder's Level*, is used mainly for sighting horizontal line of sight shots. An additional tool used with the Transit, Theodolite or Builder's Level is the *Rod*. The Rod is a long pole with graduated marks indicating feet and tenths of a foot. Your teacher will demonstrate how to use the Builder's Level and Rod to locate elevations on your proposed building site. You will use this information to construct a topographic map of your building site.

Reference: Bies, John D., Long, Robert A., *Mapping and Topographic Drafting*, 1983, South-Western Publishing, Palo Alto, CA.

Photos from http://benmeadows



Topographic Map Example

Exploring Careers in Science, Technology, Engineering & Mathematics

Footbridge Engineers, Inc.

456 High School Road, Anywhere, Missouri 65432

Possible Careers: Civil Engineer ▪ Engineering Technician ▪ Survey Technician ▪ Transportation Engineer ▪ Ecologist Environmental Scientist ▪ CAD Operator ▪ Drafter ▪ Research Technician

JOB: Appr'd By:

Survey Data Sheet

LOCATION:

Surveyor:	
Surveyor Technician:	
Recorder:	
Date of Data Collection:	

POLOR CO-ORDINATES ABOUT STATION No. _____

POINT	AZIMUTH	DISTANCE

INDICATE NORTH DIRECTION AND CONTROL STATION WITH ©

Possible Careers: Biomedical Engineer ▪ Biotechnology Engineer ▪ Computer Programmer ▪ Consultant ▪ Researcher ▪ Survey Technician ▪ Technical Writer ▪ Biologist ▪ Botanist ▪ CAD Operator ▪ Cartographer ▪ Conservation Scientist ▪ Ecologist ▪ Environmental Scientist ▪ Herpetologist ▪ Hydrologist ▪ Ichthyologist ▪ Laboratory Technician ▪ Organic Chemist ▪ Mycologist ▪ Ornithologist ▪ Statistician

Environmental Impact Study Information Sheet

An Environmental Impact Study (EIS) is a report of findings in relation to a proposed development or action in a given geographic area. Its purpose is to detail the investigations of potential impacts of the development or action on the environment and what measures will be taken to minimize these impacts. The EIS process is used to gather information that will help identify strengths and limitations of an environmental area. This report provides valuable information the designer/builder, the government officials, and the public can use in hopes to preserve or improve the environmental area for all. The EIS is usually written in a persuasive manner.

Photo Source: http://www.bigfoto.com/sites/main/forest_wood

An EIS usually contain some or all of the following components:

- Area measurement and description
- Location
- Reason for EIS
- Data collection methods (e.g. observation, sampling, photographs)
- Vegetation found within the area
- Erosion observed/measured
- Pollution observed/measured
- Water quality (if any water is in the area)
- Map of area (detailed and with an accurate key)

The National Environmental Policy Act (NEPA) [42 U.S.C. 4321 et seq.] was signed into law on January 1, 1970. This act established a national environmental policy for protection, maintenance, and enhancement of the environment.

(Reference: Environmental Sustainable Development and Action Research Projects, Volume 1, Issue 1, July 12, 2004, http://esdlc.com.au/ESDLCNewsletterJuly2004.pdf)

End of Document

Possible Career Majors: Biomedical Engineer ▪ Biotechnology Engineer ▪ Computer Programmer ▪ Consultant ▪ Researcher ▪ Survey Technician ▪ Technical Writer ▪ Biologist ▪ Botanist ▪ CAD Operator ▪ Cartographer ▪ Conservation Scientist ▪ Ecologist ▪ Environmental Scientist ▪ Herpetologist ▪ Hydrologist ▪ Ichthyologist ▪ Laboratory Technician ▪ Organic Chemist ▪ Mycologist ▪ Ornithologist ▪ Statistician

Environmental Impact Study

Researchers: _____ Print/Type Name _____ Print/Type Name

_____ Print/Type Name _____ Print/Type Name

Date Research Completed: _____
Month Day Year

Purpose of EIS: (*Describe in writing the purpose of this study and why it is needed.*)

Current Conditions of Site: (*Describe in writing the current conditions of the environment at this site. Place an N/A for no conditions existing*)

Land Contour:

Water:

Trees:

Flora:

Grasses:

Animals: _____

_____

_____

Insects: _____

_____

_____

Erosion Observed: _____

_____

_____

_____

_____

Pollution Observed: _____

_____

_____

_____

_____

END OF THIS PAGE

Scaled Map with Current Conditions: (*Attach map showing contour of land, location and name of trees, flora, grasses, buildings, waterways (wet or dry), and any other physical conditions of the site. Also indicate traffic patterns of people and animals*)

Place Map Here

Legal Description of location: _____

_____

_____

_____

_____

Provide photographs of the site below with direction of each view:

Place 3 X 5 Photo Here

Photo 1: _____

Place 3 X 5 Photo Here

Photo 2: _____

Add pages for more photos if needed.

Scaled Map with Proposed Conditions: [*Attach map showing any changes in contour of land, location and name of trees, flora, grasses, buildings, waterways (wet or dry), and any other physical conditions of the site. Also indicate changes in traffic patterns of people and animals. Indicate proposed location of footbridge*.]

Place Map Here

Rationale for new footbridge: (*Provide a narrative on the positive and negative points in regard to the impact on the environment for the proposed location of the footbridge.*)

Possible Careers: Civil Engineer ▪ Survey Technician ▪ Transportation Engineer ▪ Ecologist ▪ Environmental Scientist ▪ CAD Operator ▪ Drafter Research Technician

Bridge Design Concepts Information

Beam Bridge (Photo Courtesy of Dick Kahoe ©)

Civil Engineers are the ones that typically design bridges. The engineering design process used to create a bridge system involves the application of scientific knowledge, mathematical processes, and technology. Civil engineers go through a design process that identifies the problem, defines the problem, develops alternative solutions, analyzes and compares alternative solutions, selects the best alternative, implements the solution, and evaluates the results.

The engineer will begin the design process by interviewing the client, the person or group that needs the bridge designed and built. (See *Bridge Design Criteria* form) The engineer will investigate the proposed site to determine the physical and environmental conditions. An Environmental Impact Study is often required to determine the effects a bridge will have on that location. State and Federal environmental laws require that projects of this type not harm the environment.

Arch Bridge (Photo Courtesy of Dick Kahoe ©)

Once a suitable site has been agreed upon and the criteria (requirements) have been established, the engineer will begin designing the bridge. There are several components to a bridge that the engineer must examine and select in order to produce the most efficient, useable and safe bridge. Some of these are: bridge type and style, type of materials to use, loads (forces acting on the bridge), soil around the bridge site, and total cost of the bridge.

Bridges are usually classified in six categories. They are the beam, the truss, the arch, the cantilever, the cable-stay, and the suspension. The beam type bridge is constructed with long wood timber, concrete, or metal beams supported on each end. The truss type bridge has structural members of wood or metal arranged in triangular shapes. The arch type bridge uses a large bow shape on each side of the bridge to distribute the load to the two ends of the bridge and can be made of wood, metal, or concrete. The cantilever type bridge is similar to the beam type bridge with ends connected. The cable-stayed type

Truss Bridge (Photo Courtesy of Dick Kahoe ©)

bridge has roadbed supported by cables suspended from one or more towers. The suspension type bridge has horizontal main cables suspended from tower to tower and anchored at each end of the bridge in concrete or bedrock. Vertical cables hanging from the main cables support the roadbed.

Cantilever Bridge (Photo Courtesy NYC DOT)

Suspension Bridge (Photo Courtesy of Dick Kahoe ©)

Cable-Stayed Bridge (Photo Courtesy of Dick Kahoe ©)

References: http://www.factmonster.com/ce6/sci/A0857019.html
Cantilever Bridge Photo from
http://www.nyc.gov/html/dot/html/bridges/bridges/pulaski.html

END OF DOCUMENT

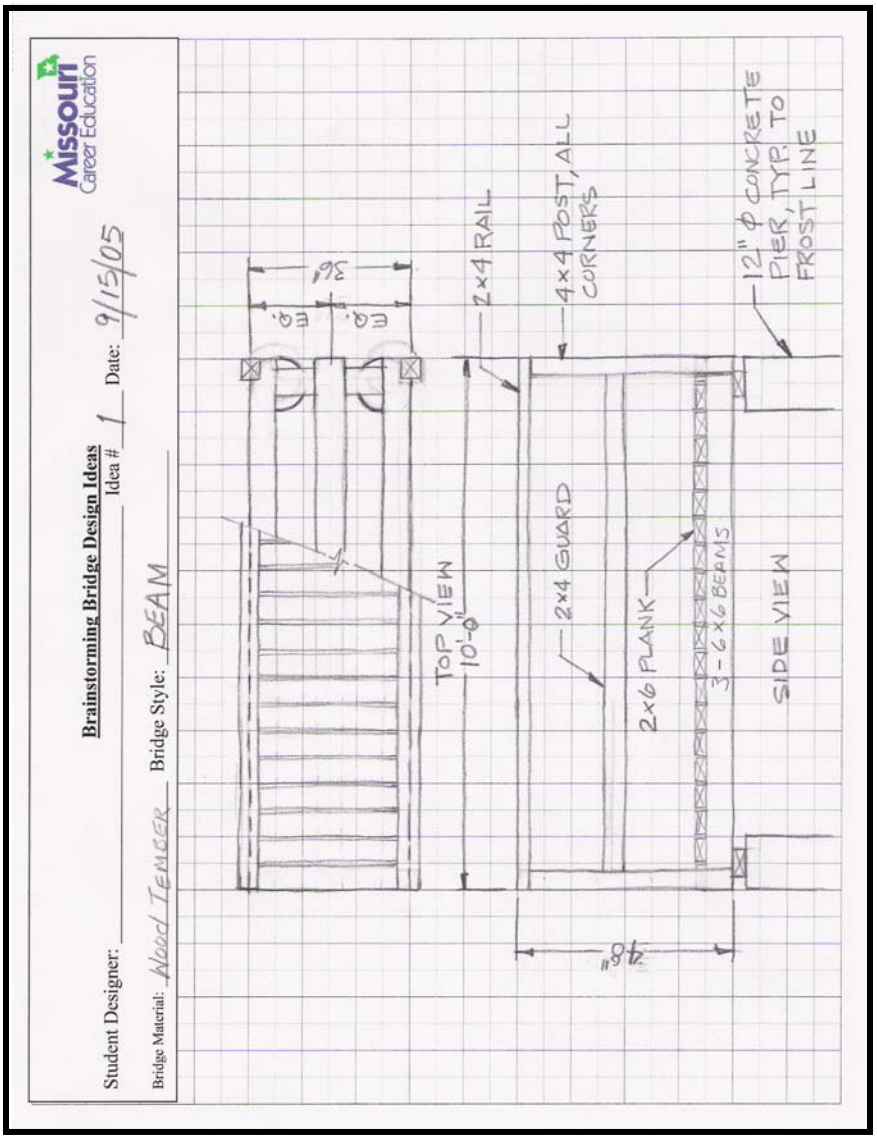
Exploring Careers in Science, Technology, Engineering & Mathematics

Possible Careers: Civil Engineer ▪ Survey Technician ▪ Transportation Engineer ▪ Ecologist ▪ Environmental Scientist ▪ CAD Operator ▪ Drafter Research Technician

Developing Bridge Design Ideas

The civil engineer will begin sketching ideas for a bridge layout once the client criteria (see *Bridge Design Criteria* activity) have been documented. These ideas are usually quick freehand sketches that record ideas the designer has in mind which meet the client's criteria. When the sketches are drawn, the engineer will also put important notes such as components, dimensions, loading calculations or other details to remind them later about such information. The date is also important to include on the sketches. Often, the engineer will produce several before deciding on one or two ideas to present to the client.

Your assignment is to sketch at least **three different ideas** with notes for the bridge design that meet the client criteria. Use separate *Brainstorming Bridge Design Ideas* forms to record each of your ideas. Show as many dimensions as you can for each of your structures. Remember, no matter what the engineer comes up with, if it does not meet the client criteria the engineer has not been successful. Once you have completed your sketches, ask another student check and sign your design to make sure it meets the client criteria. See the example shown on the right.



Drawing 1 *Brainstorming Bridge Design Ideas*

Brainstorming Bridge Design Ideas

Student Designer: _____ Idea #_____ Date: _____

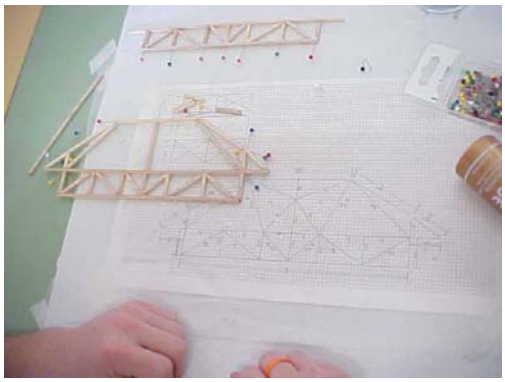
Bridge Material: _____ Bridge Style: _____ Checked By:_____

Possible Careers: Civil Engineer ▪ Survey Technician ▪ Transportation Engineer ▪ Ecologist ▪ Environmental Scientist ▪ CAD Operator ▪ Drafter Research Technician

Bridge Modeling & Testing

Building a bridge can be very expensive. Building a bridge without testing it first can not only be very costly in money if the bridge fails, but also very costly in possible personal injury. *Civil engineers* have two basic ways to test bridge designs without actually building the bridge: a mathematical model referred to as a structural model and a. physical scale model.

The structural model uses geometry, trigonometry and calculus to predict the effects of a *load* put on the bridge. Loads are forces applied to the bridge structure. These forces include the weight of anything that moves across the bridge such as people, animals or vehicles, the weight of the bridge materials, as well as natural elements such as wind, earth movement, and ice or snow. Computer software programs have been developed to simulate bridge design and testing. Physical scale models built by model makers or engineering technicians allow the engineer to visualize the bridge three dimensionally as well as conduct *destructive tests* on the bridges. Destructive testing conducted by an *engineering technologist* simply means that a load (force) is applied to the bridge until it fails. The *engineer* observes the bridge during testing and examines the model after the test. The engineer can observe where the bridge fails and then, using this information, make adjustments to the design.



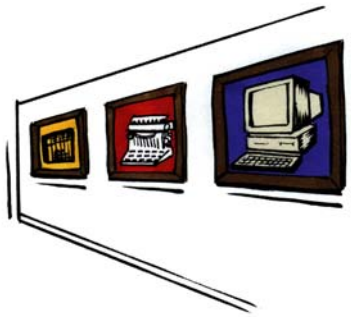
Your task is to build a scale model of your bridge design and then test it. You will use the results of your test to suggest/make changes to your design before you present your final design proposal to the Parks and Recreation Commission. Follow your teacher's instruction for constructing and testing your model. Use the *Bridge Test Results & Recommendations* form to record and report your test results.

Civil engineers and all those involved with the design of a bridge have legal and ethical responsibilities to ensure the safety of those using the bridge. Therefore it is very important that you keep accurate records of your work to document the steps taken in designing a safe bridge.

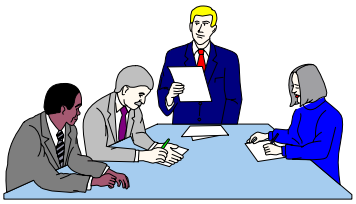
Footbridge Proposal Presentation

Footbridge Engineers, Inc. must "sell" their footbridge design idea to the Parks & Recreation Commission if they want the job. There are two parts to your presentation. The first is a *static display* of your proposal and the second is a *formal presentation* including both verbal and visual presentations.

A *static display* is simply a graphic and written display organized to quickly and clearly communicate information to a specific audience. Static displays don't involve the viewer other than through looking and reading. A static display can involve graphics and text via electronic media, for example., audio and video devices. You should have a balance between the written word and graphics such as charts, diagrams, and photographs. It is better to have fewer words to read and more graphics to look at. However, you must have enough written information to keep viewers from having to guess at what they are seeing. The static display is used to supplement the verbal and visual presentation. It can be left with the clients after the presentation to provide additional viewing time.



The *formal presentation* should provide enough information to the client to answer most of their questions, even before they have a chance to ask them. This presentation is very important because it may be the only chance you have to convince your client that your design is the best choice. When you present you should speak clearly, loud enough so everyone can hear and slow enough so people can follow what you are talking about. Most importantly, you must believe in what you are trying to sell, for example, your bridge design. The presentation is important enough that you should dress professionally and present your design in a professional manner.



The organization of your presentation is very similar to a paper you might write in English class. You should outline the information you are going to present, present the information, and then review what you presented. Your verbal presentation can be enhanced by using electronic graphics such as Power Point presentation software, overhead transparencies, posters, or a combination of all of these.

Static Display Requirements

Your static display should contain the following and be organized so the information is easy to view and understand.

1. Bold title that describes the project
2. List of all personnel involved in the project with job titles
3. List of bridge design criteria
4. Topographic map showing the location of the new footbridge
5. List of advantages for bridge location

6. Photos of site location
7. Drawings of proposed bridge
8. Photos of model bridge or placement of the actual bridge model

Formal Presentation Requirements

Your formal presentation should contain the following and be organized for smooth flow of information to your client.

1. A copy of your formal written report for each client present
2. A copy of an outline of your presentation for each client present
3. One or more of the following:
    a. Slides on overhead transparencies or in electronic format
    b. Posters of important information
    c. Video of site
    d. Model of proposed bridge

Providing information that will persuade your client to accept your proposal, is key to your presentation.

END OF DOCUMENT

Exploring Careers in Science, Technology, Engineering & Mathematics

Footbridge Engineers, Inc.

456 High School Road, Anywhere, Missouri 65432

Possible Careers: Civil Engineer ▪ Engineering Technician ▪ Survey Technician ▪ Transportation Engineer ▪ Ecologist Environmental Scientist ▪ CAD Operator ▪ Drafter ▪ Research Technician

Name:	Appr'd By:

Bridge Engineering Modeling & Testing

Bridge Design Data

Engineer:	
Engineering Technician:	
Recorder:	
Bridge Style:	
Bridge Material:	
Bridge Dimensions:	Width: Height: Length:
Bridge Mass:	In Grams: In Ounces:
Date of Test:	
Force at Failure:	In Kg: In lbs:

Calculations for Efficiency:

Provide sketch of bridge indicating Failure Points and recommendations for correcting problems

Exploring Careers in Science, Technology, Engineering & Mathematics

Daily Work Report

1234th Street PO Box 567, Big Town, Missouri 65432-0567

Possible Careers: Civil Engineer ▪ Engineering Technician ▪ Survey Technician ▪ Transportation Engineer ▪ Ecologist ▪ Environmental Scientist ▪ CAD Operator ▪ Drafter ▪ Research Technician

Job Title:	Name:	Appr'd By:
		Date:

Task Description (What I did today)

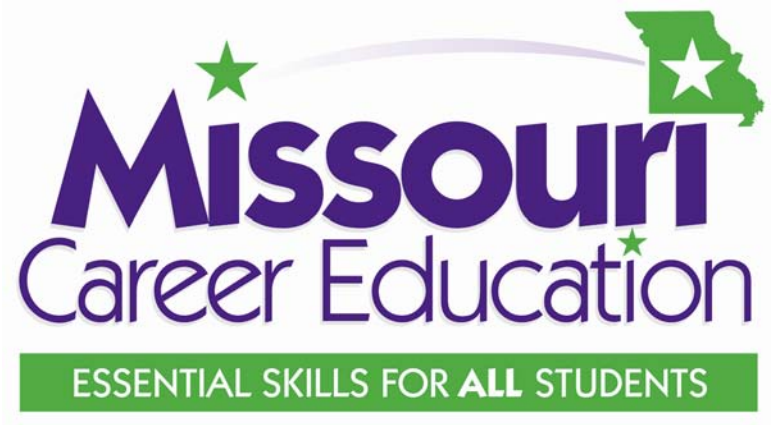
[Write in complete sentences using correct spelling, punctuation and grammar.]

Task Description for Next Working Day

[Write in complete sentences using correct spelling, punctuation and grammar.]

Tools, Equipment, and Supplies Needed for Next Working Day

	Tools	Equipment	Supplies
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			



Missouri Center for Career Education
Department of Career & Technology Education
Central Missouri State University
Warrensburg, Missouri

Division of Career Education
Department of Elementary & Secondary Education
Jefferson City, Missouri

Science, Technology, Engineering & Mathematics Career Search

Exploring Career Clusters

Course A

Architecture & Construction
Science, Technology, Engineering, and Mathematics
Manufacturing

Introduction to Career Search

Your students have spent the last few weeks in hands-on experiences within this career cluster gaining an understanding of and an appreciation for various occupations. They should also have gained some understanding of what knowledge and skills are needed to enter these occupations. This unit of study is intended to help the student gain more detailed information about specific occupations that interest them. Before attempting the search, your students should take an interest survey to give them insight and direction. Your students will then be ready to select their occupations of interest and complete the career search. Remember, a major objective of this course is for your students to gain an educated understanding of career options within specific clusters.

Teacher Preparation

There are several references available for teachers and students. You will want to view these references before finalizing your lessons and before your students begin their career search. You should visit with your guidance counselor(s) at the beginning of this course to coordinate your efforts and arrange time for the counselor to help. You should also contact your Area Career Center to arrange class presentations and/or a tour of the center facilities and programs.

Note: Your enthusiasm for this unit will be a huge encouragement for your students. Help them understand that good planning now will save them time and money later. You will also want to express the fact that plans can change and what they select now can be altered at any point in their high school and/or college life. Additionally, encourage your students to share their findings with their parents or guardians.

Although there are many resources available in print and online which you and your students can use, Missouri Kuder (http://mo.kuder.com/) is the official college and career planning program recognized by Missouri Guidance & Placement Services of the Department of Elementary and Secondary Education, Career and Technical Education Division. Your guidance counselor will be able to help you access the website if you have not done so.

Prepare a bulletin board that displays various educational options after high school in this career cluster. Be sure to include both local and distant schools as well as low to high costs schools.

Resources:

- Missouri Kuder, http://mo.kuder.com/
- Missouri Guidance and Placement Services, http://dese.mo.gov/divcareered/career_plan.htm
- Explore Careers, http://www.iseek.org/sv/10000.jsp
- Gettech, http://gettech.org/default2.asp
- Vocational Information Center, http://www.khake.com/
- Technology Careers, http://www.pathwaystotechnology.org/
- Career Voyages, US Government, http://www.careervoyages.gov

Suggested Activities

1. *Interest Assessment* (if not taken previously)

   (This activity will only need to be completed once in the semester.) Take the interest assessment (Kuder® Career Search with Person Match), the skills inventory (Kuder Skills Assessment), and print out the Composite Report from these two. If possible, enlist the help of your guidance counselor. Go to http://mo.kuder.com/ to find the assessment documents.

2. *Career Search Identity*

   You will want to make sure your students have the *STEM Pathways* chart available so they can select occupations relevant to this career cluster search. You will need to decide how many searches you want your students to complete. It is suggested that they complete one search for each of the occupational levels, Technician, Technologist, and Professional. You may ask them to complete more if time permits.

Handout: *Definitions of the Three Levels of Occupations*

This handout will give the students a brief description the three levels of occupations students might find in any career pathway. This is a way of recognizing different levels of education and skills needed for an occupation.

Handout: *MLA Citation Style Information*

Your students will be asked to cite their sources of information. This handout will give them the correct format for citing different sources. It is suggested you review this with them. You may also want to check with your English teachers and/or librarian to confirm the style(s) being taught in your building

3. *Career Center Presentation* (if not completed previously)

   Contact your career center director or guidance counselor and make arrangements for a tour of the center facilities and a presentation of the programs the center offers. If it is not possible to tour the facilities, arrange for presentations by career center faculty in your classroom or lab. Make sure the presentations include photos. If possible, make a video tour of the center with interviews by faculty and students.

Handout: *Career Center Information* (teacher designed) Design an information sheet with appropriate questions about the various programs offered by your career center in the cluster area of *Science, Technology, Engineering and Mathematics*. Include such topics as the type of activities for students, certifications available, types of jobs after the program, transferability to college, characteristics students should possess in order to be successful in each program, etc.

4. *Four-Year High School Plan*

   Enlist the assistance of your guidance counselor. You will want your students to identify courses that will prepare them for post high school employment and/or higher education programs. Use Missouri Kuder and the *Missouri Educational Career Plan* (Science, Technology, Engineering and Mathematics) form found at http://dese.mo.gov/divcareered/career_plan.htm.

Definitions of the Three Levels of Occupations

TECHNICIAN

Technicians typically build, repair, maintain, and/or operate specialized, complex, technical equipment and systems. A technician receives technical training through an apprenticeship program (on-the-job), a technical certification program, or a two-year associate degree college program.

TECHNOLOGIST

Technologists typically work as technical managers and must be able to understand theories and apply the principles and concepts of mathematics, science, and applications of computer fundamentals. Generally, a technologist is college educated with a four-year degree, which includes general education, technical specializations, and technical management.

PROFESSIONAL

A professional is a person who has an occupation requiring training in the liberal arts or the sciences and usually advanced study (course work after the bachelor's degree or a master's degree) in a specialized field such as, but not limited to, architects, engineers, upper level managers, certified accountants, and educators.

Occupational Levels

STEM		
Technician	**Technologist**	**Professional**
Agricultural Technician	Aeronautical Engineer	Analytical Chemist
Computer Science Technician	Aerospace Engineer	Applied Mathematician
Electronics Technician	Agricultural Engineer	Archaeologist
Facilities Technician	Analytical Chemist	Herpetologist
Hazardous Waste Technician	Application Engineer	Mathematician
Industrial Engineering Technician	Archaeologist	Paleontologist
Laboratory Technician	Architectural Engineer	Physicist
Manufacturing Technician	Astronomer	Project Manager
Materials Lab & Supply Technician	Astrophysicist	Researcher
Network Technician	Atmospheric Scientist	Spectroscopist
Nuclear Technician	Automotive Engineer	Statistician
Packaging Technician	Biologist	Toxicologist
Quality Technician	Biomedical Engineer	Zoologist
Radio/TV Broadcast Technician	Biotechnology Engineer	
Research Technician	Botanist	
Sound Technician	CAD Operator	
Survey Technician	Cartographer	
	Chemical Engineer	
	Chemist	
	Civil Engineer	
	Communications Engineer	
	Communications Technologist	
	Computer Engineer	
	Computer Hardware Engineer	
	Computer Programmer	
	Computer Software Engineer	

Note: The above information is referenced from various internet searches.
It is based solely on the interpretation of the author and may be altered at the teacher's discretion.

STEM con't		
Technician	**Technologist**	**Professional**
	Conservation Scientist	
	Construction Engineer	
	Cosmologist	
	Demographer	
	Development Engineer	
	Drafter	
	Ecologist	
	Electrical Engineer	
	Electronmicroscopist	
	Energy Transmission Engineer	
	Engineering Consultant	
	Environmental Engineer	
	Environmental Scientist	
	Fire Protection Engineer	
	Geneticist	
	Geologist	
	Geophysicist	
	Geoscientist	
	Geothermal Engineer	
	Hazardous Waste Engineer	
	Human Factors Engineer	
	Ichthyologist	
	Industrial Engineer	
	Inorganic Chemist	
	Licensing Engineer	
	Mammalogist	
	Manufacturing Engineer	
	Manufacturing Processes Engineer	
	Marine Engineer	
	Materials Analyst	
	Materials Engineer	
	Mechanical Engineer	
	Metallurgic Engineer	
	Meteorologist	
	Microbial Physiologist	

Note: The above information is referenced from various internet searches.
It is based solely on the interpretation of the author and may be altered at the teacher's discretion.

STEM con't		
Technician	**Technologist**	**Professional**
	Mining Engineer	
	Mycologist	
	Naval Engineer	
	Nuclear Engineer	
	Numerical Analyst	
	Nutritionist	
	Ocean Engineer	
	Oceanographer	
	Operations Research Engineer	
	Organic Chemist	
	Packaging Engineer	
	Paleontologist	
	Petroleum Engineer	
	Pharmaceutical Engineer	
	Plastics Engineer	
	Polymer Scientist	
	Power Systems Engineer	
	Product Design Engineer	
	Project Engineer	
	Prototype Engineer	
	Protozoologist	
	Quality-Control Scientist	
	Radio Chemist	
	Radiology Engineer	
	Safety Engineer	
	Science Teacher	
	Software Engineer	
	Structural Engineer	
	Systems Design Engineer	
	Technical Sales Manager	
	Technologist	
	Telecommunications Engineer	
	Textile Engineer	
	Transportation Engineer	
	Zoologist	

Note: The above information is referenced from various internet searches.
It is based solely on the interpretation of the author and may be altered at the teacher's discretion.

Career Pathways: Engineering and Technology • Science and Math

Career Search Identity

Student Name: **Graduation Year:**

Print Name

Activity Completed: **Activity Assessment:**

Date

Your career search is designed to help you gain understanding and knowledge about career possibilities within your interest of the Career Cluster *Science, Technology, Engineering & Mathematics*. Based on your recent experiences in this class and the interest assessment you took in Kuder, you will choose at least one occupational Pathway and an occupation from each of the three levels of occupations: Technician, Technologist, and Professional. When you have completed your search, you will:

1. know what level of education you must have.
2. know what technical skills you must have.
3. know what academic skills you must have.
4. know what the working conditions will be.
5. know what the average wage/salary will be.
6. know what the outlook for jobs will be.
7. know where the jobs will be found.

You should select your occupations from the *Science, Technology, Engineering & Mathematics Cluster Pathways* chart. Within each Pathway, occupations can be divided into three levels: 1. Technician, 2. Technologist, and 3. Professional. You are to select one occupation from each of the occupational levels which may be from one Pathway or all three Pathways. Your teacher can help you decide what level your choice of occupation falls under. Complete the following information:

Occupations I will research:

Technician:

Pathway Occupation

Technologist:

Pathway Occupation

Professional:

Pathway Occupation

Career Pathways: Engineering and Technology • Science and Math

Pathway:

Activity Completed: **Activity Assessment:**

Date

Student Name: **Graduation Year:**

Occupation: Level: ☐Technician ☐Technologist ☐Professional

CHECK ONE ABOVE

Sources of Information - Refer to Bibliographic Style Sheet for correct format to cite references:

Work Activities - Provide at least four activities this person would do on the job:

1.
2.
3.
4.

Work Conditions - List at least three physical conditions you would work under and if you would be required to work with other people:

1.
2.
3.
4. Are you required to work with other people? ☐ Yes ☐ No

Skills, Abilities & Knowledge - List the required skills, abilities & knowledge in each of the areas listed below:

Communication:

Math Level:

Science Knowledge:

Technical Knowledge:

Tool/Equipment Skill:

Preparation - Check all education or training you need to enter this occupation:

☐High School Diploma ☐GED ☐On-The-Job Training/Apprenticeship ☐Technical ☐University

Wages - List the hourly wage and the annual expected income:

Amount per Hour: Amount per Month: Amount per Year:

Outlook (Will there be jobs available in this occupation in the future?)

Number of Jobs now available: Number of Jobs available in 5 Years 10 Years

Major Employers - What type of companies will hire you?

1.
2.
3.
4.
5.
6.

END OF DOCUMENT

Educational Career Plan

Career Path: Industrial & Engineering Technology

Career Cluster: Science, Technology, Engineering & Mathematics

Career Pathway:

Graduation Year:

Date: _____

Student Name: _____

Student Signature: _____

Advisor Signature: _____

Parent/Guardian Signature (if required):

_____

High School

9th Grade	*10th Grade*	*11th Grade*	*12th Grade**
English I	English II	English III	English IV
Algebra I or Geometry	Geometry or Algebra II	Algebra II, Pre-Calculus, or Trigonometry	Trigonometry or Calculus
Physical Science or Biology I	Biology I or Chemistry I	Chemistry or Physics	AP Biology, AP Chemistry, or AP Physics
Geography/State History	World History	American History	Economics/Government
PE/Health or Fine Arts	PE/Health or Fine Arts		Personal Finance
			Practical Art (if needed)
Career Major Elective(s) Agriscience I Foundations Course (PLTW) Technology Education	***Career Major Elective(s)*** Agriscience II Foundations Course (PLTW) Technology Education	***Career Major Coursework:*** **Aerospace Engineering; Agriculture Power & Technology; **Biotechnical Engineering; **Civil Engineering and Architecture; **Computer Integrated Manufacturing; Computer Numerical Control; Drafting and CAD; Drafting and Design; Electronics; **Engineering Design & Development; Industrial Maintenance; Precision Machining; Principles of Ag. Technology	
Additional Coursework Foreign Language or Computer Technology	***Additional Coursework*** Foreign Language or Computer Technology		

Postsecondary

Area Career Center	*Community College*	*College/University*	*Other*
❑ Automated Manufacturing Technology	❑ Biology	❑ Biochemistry	❑ Apprenticeship
❑ Drafting and CAD	❑ Chemistry	❑ Biology	❑ Military
❑ Electronics	❑ Design Engineering Technology	❑ Chemistry	❑ On-the-Job Training
❑ Industrial Maintenance	❑ Industrial Drafting	❑ Civil Engineering	
❑ Manufacturing Engineering Technology	❑ Mathematics	❑ Education	
❑ Precision Machining	❑ Physics	❑ Management Science and Systems Analysis	
	❑ Pre-Engineering	❑ Mathematics	
		❑ Mechanical Engineering	
		❑ Medical Engineering	
		❑ Physics	

Work-based Learning Opportunities	*Relevant High School Intra-Curricular/Co-Curricular Experiences*	*Graduation Exams*

Career Enhancement Options			
	After School Employment Cooperative Occupational Experience Internship/Mentorship Job-Shadowing On-The-Job Training Service Learning	Career and Technical Student Organization: FFA SkillsUSA Technology Student Association (TSA) Other high school activities:	___U.S. Constitution ___MO Constitution

Adapted from National Career Cluster

* 12th grade year should include at least 3 academic courses including college prep math or science.

** These courses are part of the Project Lead The Way curriculum. More information is available at www.pltw.org.

Note: All Career and Technical Education courses count as a practical arts credit.

MLA Citation Style

This guide provides a basic introduction to the MLA citation style. It is based on the 6th edition of the MLA Handbook for Writers of Research Papers published by the Modern Language Association in 2003.

Copies are available at the Vanier Library Reference Desk, in the Webster Library Reference Collection and on 3-hour Reserve (Webster). The call number for the handbook is LB 2369 G53 2003.

The MLA Handbook is generally used for academic writing in the humanities. The handbook itself covers many aspects of research writing including selecting a topic, evaluating sources, taking notes, plagiarism, the mechanics of writing, the format of the research paper as well as the way to cite sources.

This guide provides basic explanations and examples for the most common types of citations used by students. For additional information and examples, refer to the MLA Handbook.

Parenthetical references in the text

Parenthetical documentation allows you to acknowledge a source within your text by providing a reference to exactly where in that source you found the information. The reader can then follow up on the complete reference listed on the Works Cited page at the end of your paper.

- In most cases, providing the author's last name and a page number are sufficient:

  In response to rapid metropolitan expansion, urban renewal projects sought "an order in which more significant kinds of conflict, more complex and intellectually stimulating kinds of disharmony, may take place" (Mumford 485).

- If there are two or three authors, include the last name of each:

  (Winks and Kaiser 176)

  (Choko, Bourassa, and Baril 258-263)

- If there are more than three authors, include the last name of the first author followed by "et al." without any intervening punctuation:

  (Baldwin et al. 306)

- If the author is mentioned in the text, only the page reference needs to be inserted:

  According to Postman, broadcast news influences the decision-making process (51-63).

Parenthetical documentation is not used for electronic or web documents if there is no pagination.
Further examples and explanations are available in Chapter 6 of the MLA Handbook.

Works Cited

The alphabetical list of works cited that appears at the end of your paper contains more information about all of the sources you've cited allowing readers to refer to them, as needed. The main characteristics are:

- The list of Works Cited must be on a new page at the end of your text
- Entries are arranged alphabetically by the author's last name or by the title if there is no author
- Titles are underlined (not *italicized*) and all important words should be capitalized
- Entries are double-spaced (for the purposes of this handout, single-spacing is used)

Below are some examples of the most common types of sources including online sources (web and databases).

Book with one author

Mumford, Lewis. The Culture of Cities. New York: Harcourt, 1938.

Book with two or three authors

Francis, R. Douglas, Richard Jones, and Donald B. Smith. Destinies: Canadian History Since Confederation. Toronto: Harcourt, 2000.

Book with more than three authors

Baldwin, Richard et al. Economic Geography and Public Policy. Princeton: Princeton UP, 2003.

Two or more books by the same author

Replace the author's name by three hyphens and arrange alphabetically by the book's title

Postman, Neil. Amusing Ourselves to Death: Public Discourse in the Age of Show Business. New York: Viking, 1985.

---. The Disappearance of Childhood. New York: Vintage, 1994.

Anthology or compilation

Abate, Corinne S., ed. Privacy, Domesticity, and Women in Early Modern England. Burlington, VT: Ashgate, 2003.

Work in an anthology or an essay in a book

Naremore, James. "Hitchcock at the Margins of Noir." Alfred Hitchcock: Centenary Essays. Eds. Richard Allen and S. Ishii-Gonzalès. London: BFI, 1999.

Book by a corporate author

Associations, corporations, agencies and organizations are considered authors when there is no single author

Organisation for Economic Co-operation and Development. Action Against Climate Change: The Kyoto Protocol and Beyond. Paris: OECD, 1999.

Article in a reference book or an entry in an encyclopedia

If the article/entry is signed, include the author's name; if unsigned, begin with the title of the entry

Guignon, Charles B. "Existentialism." Routledge Encyclopedia of Philosophy. Ed. Edward Craig. 10 vols. London: Routledge, 1998.

A translation

Kafka, Franz. The Metamorphosis. Trans. and Ed. Stanley Corngold. New York: Bantam, 1972.

A government publication

Canada. Dept. of Foreign Affairs and International Trade. Freedom From Fear: Canada's Foreign Policy for Human Security. Ottawa: DFAIT, 2002.

United Nations. Dept. of Economic and Social Affairs. Population Division. Charting the Progress of Populations. New York: UN, 2000.

Book in a series

Bloom, Harold, ed. André Malraux. Modern Critical Views. New York: Chelsea House, 1988.

Article in a journal

Ferrer, Ada. "Cuba 1898: Rethinking Race, Nation, and Empire." Radical History Review 73 (1999): 22-49.

Man, Glenn K. S. "The Third Man: Pulp Fiction and Art Film." Literature Film Quarterly 21.3 (1993): 171-178.

Article in a newspaper or magazine

Semenak, Susan. "Feeling Right at Home: Government Residence Eschews Traditional Rules." Montreal Gazette 28 Dec. 1995, Final Ed.: A4.

Driedger, Sharon Doyle. "After Divorce." Maclean's 20 Apr. 1998: 38-43.

A review

Kirn, Walter. "The Wages of Righteousness." Rev. of Cloudsplitter, by Russell Banks. New York Times Book Review 22 Feb. 1998: 9.

Kauffmann, Stanley. "A New Spielberg." Rev of Schindler's List, dir. Steven Spielberg. New Republic 13 Dec. 1993: 30.

Television or radio program

"Scandal of the Century." Narr. Linden MacIntyre. The Fifth Estate. CBC Television. 23 Jan. 2002.

Sound recording

Ellington, Duke. "Black and Tan Fantasy." Music is My Mistress. Musicmasters, 1989.

Film, video recording or DVD

The Shining. Dir. Stanley Kubrick. Perf. Jack Nicholson, Shelley Duvall. Warner Bros., 1980.

Macbeth. Dir. Roman Polanski. Perf. Jon Finch, Francesca Annis, and Nicholas Selby. 1971. DVD. Columbia, 2002.

Musical composition, published score

Beethoven, Ludwig van. Symphony no. 4 in B-flat major, op. 60. Mineola, NY: Dover, 2001.

Work of art, photographed, in a book

Cassatt, Mary. Mother and Child. 1890. Wichita Art Museum, Wichita. American Painting: 15601913. By John Pearce. New York: McGraw, 1964. Slide 22.

• **Article from a database**

Provide the same information as you would for a printed journal article and add the name of the database, the platform of the database (if applicable), the access provider (Concordia University Libraries), the date of access and the general URL for the database

NOTE - If the article is in HTML only, pagination is not required. However, you can include the start page followed by a hyphen, a space and then a period. If a PDF version is available, provide pagination.

Brennan, Katherine Stern. "Culture in the Cities: Provincial Academies During the Early Years of Louis XIV's Reign." Canadian Journal of History 38.1 (2003): 19-42. CBCA Complete. ProQuest. Concordia University Libraries. 29 Mar. 2004 <http://www.proquest.com>.

Dussault, Marc and Bruce G. Barnett. "Peer-assisted Leadership: Reducing Educational Managers' Professional Isolation." Journal of Educational Administration 34.3 (1996): 5- . ABI/INFORM Global. ProQuest. Concordia University Libraries. 29 Mar. 2004 <http://www.proquest.com>.

Heming, Li, Paul Waley, and Phil Rees. "Reservoir Resettlement in China: Past Experience and the Three Gorges Dam." The Geographical Journal 167.3 (2001): 195-212. Academic Search Premier. EBSCOhost. Concordia University Libraries. 29 Mar. 2004 <http://search.epnet.com>.

• **Web page**

"Joyce Wieland." Celebrating Women's Achievements: Women Artists in Canada. 2000. National Library of Canada. 29 Mar. 2004. <http://www.nlc-bnc.ca/women/h12-523-e.html>.

• **Internet site**

Legends of our Times: Native Ranching and Rodeo Life on the Plains and Plateau. 22 Jan. 1999. Canadian Museum of Civilization. 29 Mar. 2004. <http://www.civilisations.ca/aborig/rodeo/rodeo00e.html>.

• **Article in online periodical**

Sehmby, Dalbir S. "Wrestling and Popular Culture." CCLWeb: Comparative Literature and Culture 4.1 (2002). 29 Mar. 2004 <http://clcwebjournal.lib.purdue.edu/clcweb02-1/sehmby02.html>.

Revised: March 2004