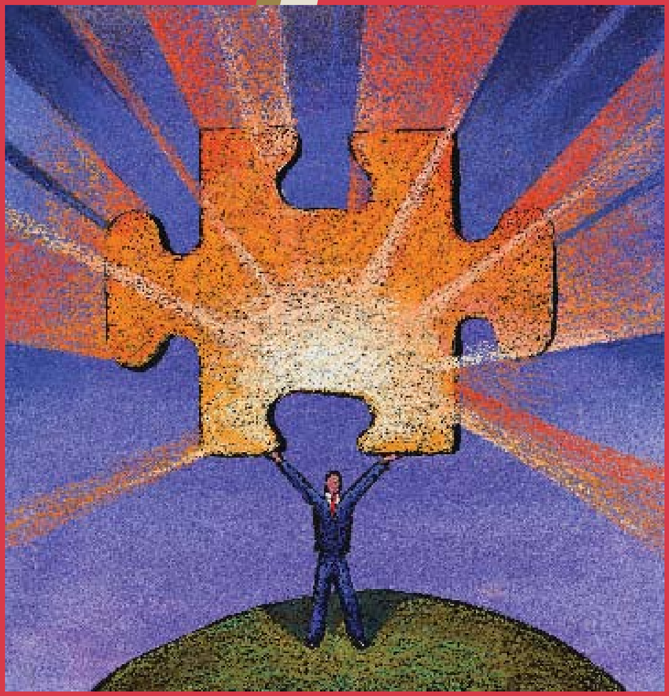

# Industrial Core Instructor Guide

*An Industrial Technology Core Curriculum Guide*

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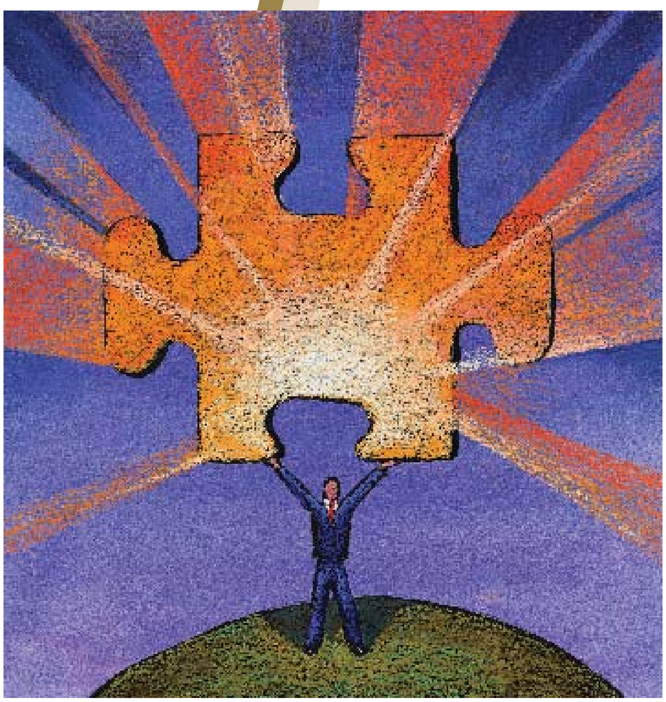
views of the National Science Foundation.



# Industrial Core Instructor Guide

*An Industrial Technology Core Curriculum Guide*

2007

# Contents

# Introduction to Industrial Technology Core

## What is the Industrial Technology Core Curriculum?

The Industrial Core is a curriculum designed to teach English, communications, mathematics, technology, teamwork, and problem-solving competencies in context for various industrial technology majors. It is an integrated, problem-based course of study that models the workplace through the use of industrial-type problems and student and faculty teams. Industrial technology, mathematics, and communications are taught concurrently in the context of solving workplace-related problems.

The Industrial Core Instructor Guide is an adaptation of the Technology Gateway Instructor Guide, a pre-engineering technology curriculum guide developed by the SCATE Center of Excellence with the input and validation of industry partners.

## What are the strengths of the Industrial Technology Core Curriculum? The Core Curriculum

- Targets recruitment, retention, and graduation of more highly skilled technicians.
- Supports the success of a diverse population of students, including students traditionally under-represented in industrial technology programs.
- Provides an instructional approach and curriculum that have been validated by industry.
- Uses open-ended problem scenarios that reflect real-world industry problems as closely as possible while, at the same time, covering the appropriate subject-matter content. Problem scenarios provide a context and purpose for learning.
- Shows relationships among the subject areas of mathematics, technology, and communications.
- Helps answer student questions: Why do I need to learn this? How is it relevant? How will I use it?
- Incorporates effective teaching methodologies and concepts, such as collaborative learning/active learning, coaching, and multiple intelligences theory.
- Provides more opportunities for hands-on, inquiry-based learning, thus enabling students to apply what they are learning immediately.
- Uses student teams to solve problems, thereby creating an additional support system for learning and encouraging student participation and retention.
- Provides additional instructor support because instructors are part of a teaching team that coordinates student learning.
- Supports technology applications for data collection and analysis, research, problem solving, and presentations.

## Who should consider using the Industrial Technology Core Curriculum?

Industrial Technology Core Curriculum is available for use in two-year community and technical colleges and high schools. Taught in a two-year technical/community college setting, the Industrial Core is a set of three courses (e.g., Fundamentals of Maintenance Technology, IMT 106; Fundamentals of Mathematics, MAT106; and Fundamentals of English, ENG 106) and includes career exploration. The curriculum is targeted for students enrolled in industrial technology programs. Industrial Core is designed to be a general education core of study for industrial technology or other technology-based majors. Students are more likely to complete general education requirements and earn degrees with this integrated content approach.

The Industrial Core meets a variety of needs at the high school level. It helps meet the needs of students who require additional skills in mathematics, science, and/or communications in order to qualify for college-level industrial technology programs. The Industrial Core also helps students who need hands-on experiences that enable them to learn teaming and other workplace skills. In some cases, students may take Industrial Core courses for dual credit (high school and technical/community college credit).

**Industrial Core Project Numbers and Titles**

1. Introduction to Technology Careers
2. Basic Hand Tools
3. Mechanical Advantage
4. Basic Electricity
5. Hydraulic Systems

## How does the integrated, problem-based approach work?

Interdisciplinary faculty team members coach student teams through a structured, problem-based learning process that includes the following phases:

- Preparing students to meet the problem,
- Leading a "What do we need to know?" discussion,
- Gathering and sharing information,
- Generating solutions, and
- Assessing performance.

After students are introduced to a loosely structured problem, they identify what they know, how they know it (opinion versus scientific knowledge), and what information and skills they need to solve the problem (see Need-to-Know Chart on page 10). Faculty-guided instructional sessions that replace traditional classroom lectures help students gain content-specific knowledge. Students develop team recommendations for solving problems and present their work in written form or via media presentations.

Industrial Core classrooms should closely model the workplace environment. For example, student team work space may be equipped with computer stations and tables for team meetings and tools such as white boards and/or bulletin boards where their work may be posted throughout a project. Student teams may remain in their work space while instructors come and go to coach and deliver just-in-time instruction.

## Is the Industrial Technology Core Curriculum flexible?

The Industrial Core is designed to give instructor teams and their colleges or schools as much flexibility as possible to meet local needs. Instructors determine the level of proficiency that is required of students. Student handouts of the problem scenarios are provided, and instructors select textbooks and other resources for students. Other local decisions include curriculum scheduling, course syllabi, scope and sequence of content, lesson plans, assessment and grading procedures, and technology resources.

## What resources are available to support instructors?

A number of resources are available in this instructor guide to assist in implementing the Industrial Technology Core Curriculum, including

- Objectives and instructor notes with each project,
- Suggested learning activities,
- Content strands in each project,
- Classroom resources, including web sites,
- Sample rubrics for evaluating projects,
- A problem-based learning Need-to-Know Chart template,
- Student competencies for each project and a master competency list,
- A master equipment list and equipment/resource lists for each project, and
- Student handouts for each project.

Additional information may be found on the SCATE web site (www.scate.org) or by contacting SCATE by phone (843-676-8547) or e-mail (scate@fdtc.edu).

## Problem-Based Learning
## Need-To-Know Chart

| What do we know? | What do we need to know? | How do we find out? |
|---|---|---|
| | | |

# Scope and Sequence Charts

## Industrial Technology Core Projects

#1 Introduction to Technology Careers
#2 Basic Hand Tools
#3 Mechanical Advantage
#4 Basic Electricity
#5 Hydraulic Systems

### Technology Scope and Sequence

| Industrial Technology Topic | Project Number #1 | #2 | #3 | #4 | #5 |
|---|---|---|---|---|---|
| Physical systems | ✓ | | | | |
| Technology careers | ✓ | | | | |
| Internet research | ✓ | ✓ | | ✓ | ✓ |
| Random and systematic error | | | ✓ | | |
| Simple machines | | | ✓ | | |
| Work | | | ✓ | | |
| Workplace safety | | ✓ | ✓ | ✓ | ✓ |
| Data collection | | | ✓ | ✓ | ✓ |
| Mass, weight, density | | | ✓ | | ✓ |
| Resistance, current, voltage | | | | ✓ | |
| Ohm's law | | | | ✓ | |
| Power | | | | ✓ | |
| Series and parallel circuits | | | | ✓ | |
| Precision, accuracy, tolerance | | ✓ | | ✓ | |
| Pressure | | | | | ✓ |
| Rate | | | | | ✓ |
| Hydraulic systems | | | | | ✓ |
| Instrumentation, measurements | | ✓ | ✓ | | ✓ |
| Print reading | | ✓ | | ✓ | ✓ |

### Communications Scope and Sequence

| Communications Topic | Project Number #1 | #2 | #3 | #4 | #5 |
|---|---|---|---|---|---|
| Technical writing | ✓ | ✓ | ✓ | ✓ | ✓ |
| Short reports | | | ✓ | ✓ | |
| Memos/letters | | | | ✓ | |
| Email messages | | | | ✓ | |
| Proposals | | | | ✓ | ✓ |
| Process reports | | ✓ | ✓ | ✓ | |
| Page layout | ✓ | | | | |
| Research techniques | ✓ | ✓ | ✓ | ✓ | ✓ |
| Internet sources | ✓ | | | ✓ | |
| Interviews | ✓ | ✓ | | | |
| Print sources | ✓ | | | ✓ | |
| Oral presentations | ✓ | ✓ | ✓ | ✓ | ✓ |
| Collaborative reports | ✓ | ✓ | ✓ | ✓ | ✓ |
| Visuals | ✓ | | | | |
| Presentation software (PowerPoint) | ✓ | | ✓ | | ✓ |

## Industrial Technology Core Projects

#1 Introduction to Technology Careers
#2 Basic Hand Tools
#3 Mechanical Advantage
#4 Basic Electricity
#5 Hydraulic Systems

**Mathematics Scope and Sequence**

| Mathematics Topic | Project Number | | | | |
|---|---|---|---|---|---|
| | #1 | #2 | #3 | #4 | #5 |
| Order of operations | ✓ | | | | |
| SI System and U.S. Customary[1] | | ✓ | ✓ | ✓ | ✓ |
| Linear measurement | | ✓ | | | |
| Mass and weight measurement | | | ✓ | | ✓ |
| Units and dimensional analysis | | | ✓ | ✓ | ✓ |
| Charts and graphs | ✓ | | | ✓ | |
| Data tables | | | ✓ | | |
| Exponents | | | | ✓ | ✓ |
| Scientific and engineering notation | | | | ✓ | ✓ |
| Precision, accuracy, tolerance | | ✓ | | | |
| Percent | ✓ | | | | |
| Spreadsheets | ✓ | | | | |
| Calculator and computer skills | ✓ | | | | |
| Algebraic expressions | | ✓ | | | |
| Linear equations | | | ✓ | ✓ | |
| Ratio and proportion | | ✓ | ✓ | | |
| Formulas | | | ✓ | ✓ | |
| Literal equations | | | ✓ | ✓ | |
| Rational equations | | | | ✓ | |
| Statistics | ✓ | | | | |
| Cartesian graphing | | | | ✓ | |
| Angles and angle measurements | | | | | ✓ |
| Area | | | | | ✓ |
| Volume | | | | | ✓ |
| Right triangles | | | | | ✓ |

[1]Systeme International d'Unites, the international system of units now recommended for most scientific purposes. U.S. Customary units are sometimes referred to as the English or U.S. Standard System.

# Industrial Technology Core
# Student Competencies

**1.0 Basic numeration**

- 1.1 Perform basic calculator operations.
  - 1.1.1 Perform basic arithmetic operations with and without a calculator.
  - 1.1.2 Find the square and square root of a number using a calculator.*
  - 1.1.3 Calculate products and quotients using scientific notation.*
  - 1.1.4 Evaluate arithmetic expressions involving parentheses using a calculator.
  - 1.1.5 Calculate percentages.

**2.0 Basic measurements in solving problems**

- 2.1 Define and use the SI system of measurement.
  - 2.1.1 Define and use SI prefixes.
  - 2.1.2 Convert units within the SI system of measurement.
  - 2.1.3 Recognize the characteristics of common SI units in a working environment.

- 2.2 Perform linear two-dimensional and three-dimensional measurements.
  - 2.2.1 Distinguish between simple and compound units (measurements).*

**3.0 Basic algebra**

- 3.1 Evaluate algebraic expressions.
  - 3.1.1 Evaluate and use rational expressions.
  - 3.1.2 Simplify and evaluate radical expressions.*
  - 3.1.3 Evaluate algebraic expressions using order of operations.
  - 3.1.4 Evaluate algebraic expressions containing integer exponents.*
  - 3.1.5 Simplify, evaluate, and perform operations with polynomials.*
  - 3.1.6 Use ratio and proportion to solve problems.

- 3.2 Solve linear equations.
  - 3.2.1 Use linear equations to solve problems involving real-world applications.
  - 3.2.2 Simplify and solve linear equations.
  - 3.2.3 Simplify and solve literal equations.
  - 3.2.4 Solve linear equations by graphing on a coordinate plane.
  - 3.2.5 Organize data in tabular and graphical form.

- 3.3 Evaluate exponential expressions.
  - 3.3.1 Use a calculator to evaluate and perform operations with exponential expressions.

- 3.4 Use spreadsheets to solve problems.
  - 3.4.1 Use data tables to organize data.
  - 3.4.2 Use spreadsheets to evaluate data and perform basic calculations.

- 3.5 Use dimensional analysis to solve problems involving measurements.
  - 3.5.1 Use dimensional analysis to solve problems involving a change of units such as SI to U.S. Customary and U.S. Customary to SI.

- 3.6 Use functions.
  - 3.6.1 Evaluate function values for given values of the independent variable.*

**Enabling competency — not directly related to problem scenarios.*

**4.0 Basic geometry**

4.1 Apply the principles of geometric angles.

4.1.1 Use a protractor to measure angles.
4.1.2 Identify acute, obtuse, and right angles.
4.1.3 Determine when angles are congruent.

4.2 Recognize two-dimensional shapes.

4.2.1 Identify triangles, quadrilaterals, pentagons, and hexagons.

4.3 Recognize three-dimensional shapes.

4.3.1 Identify spheres, prisms, pyramids, cones, and cylinders.

4.4 Determine perimeter, area, and volume.

4.4.1 Measure the perimeter of irregular shapes.
4.4.2 Determine the area of triangles, quadrilaterals, and circles.
4.4.3 Determine the volume of spheres, pyramids, cones, cylinders, and prisms.

**5.0 Basic statistics**

5.1 Collect, organize, and present quantitative and qualitative data.

5.1.1 Collect data in a problem-solving setting using investigation, interviews, and/or experiments.
5.1.2 Organize data in a logical manner.
5.1.3 Present data using oral, written, and visual methods.

5.2 Define and calculate measures of central tendencies.

5.2.1 Determine the mode, median, and mean of a set of data.

5.3 Present data graphically.

5.3.1 Create and interpret (x,y) graphs, bar charts, histograms, circle graphs, line charts, and pictograms.

**6.0 Right triangle trigonometry**

6.1 Determine the relationships of right triangle sides and angles.

6.1.1 Use the pythagorean theorem to solve problems involving right triangles.
6.1.2 Define and use adjacent, opposite, and hypotenuse in describing the ratios of sides in a right triangle.
6.1.3 Define sine, cosine, and tangent of an angle.
6.1.4 Use a calculator to determine the values of trigonometric ratios.

**7.0 Simple machines, electricity, and weights and measures**

7.1 Apply simple machines.

7.1.1 Define work as it relates to simple machines.
7.1.2 List the types of simple machines and describe their basic characteristics.
7.1.3 Determine the mechanical advantage and efficiency of simple and compound machines.
7.1.4 Explain the proper use of basic hand tools.
7.1.5 Select proper hand tools for an assembly operation.

7.2 Apply the basics of electricity.

7.2.1 Describe the difference between alternating and direct current.
7.2.2 Define the difference between series and parallel circuits.
7.2.3 Apply Ohm's law.
7.2.4 Use simple meters to measure electrical properties.
7.2.5 Calculate power for electrical devices.

7.3 Apply the uses of weights and measures.

7.3.1 Measure and describe length using different systems of units.
7.3.2 Determine area using different systems of units.
7.3.3 Determine mass using various types of balances.
7.3.4 Use basic analog measuring scales.

7.3.5 Distinguish between mass and weight.
7.3.6 Select the proper measuring instrument for linear measurements.

**8.0 Hydraulics**

8.1 Apply the principles of hydraulics.
- 8.1.1 Define pressure.
- 8.1.2 Calculate force given pressure and area.
- 8.1.3 State Pascal's principle.

**9.0 Rate**

9.1 Define and calculate speed as time rate of change of distance.

9.2 Define and calculate production rate.

**10.0 Print reading**

10.1 Interpret basic blueprint symbols.

10.2 Sketch/draw diagrams for mechanical systems.

**11.0 Laboratory/shop skills and techniques**

11.1 Practice lab/shop safety procedures.
- 11.1.1 Identify the hazards of workplace equipment and tools.
- 11.1.2 Wear proper personal protective equipment and clothing.
- 11.1.3 Read and obey all safety instructions and emergency procedures.
- 11.1.4 Identify from MSDS sheets the proper procedures for handling chemicals.

11.2 Write logical procedural steps for performing an assembly.

11.3 Identify relevant experimental errors.

11.4 Distinguish between random and systematic errors.

**12.0 Gather information**

12.1 Perform research in industrial fields to gather information.
- 12.1.1 Use specialized general reference works including dictionaries, encyclopedias of applied science and technology, manuals, handbooks, government publications, and others.
- 12.1.2 Use technical journals and periodicals.
- 12.1.3 Identify standard symbols used in blueprints.
- 12.1.4 Use electronic sources/databases for research.
- 12.1.5 Take notes by summarizing, paraphrasing, and quoting material.
- 12.1.6 Document researched materials for Works Consulted page and within the body of a paper.

12.2 Use non-print sources to gain information.
- 12.2.1 Perform fact-finding interviews with individuals knowledgeable in field.
- 12.2.2 Use pre-writing techniques (e.g., listing, clustering, journalistic questions, dramatization) to develop ideas.
- 12.2.3 Summarize information from lectures, seminars, workshops, training sessions, laboratory activities.

**13.0 Organize information**

13.1 Apply basic information organizational techniques.
- 13.1.1 Outline information (working and formal).
- 13.1.2 Develop central idea statement (thesis) with a plan of development (essay map).
- 13.1.3 Use appropriate organizational patterns (causal analysis, compare/contrast, instructional, description, narration, persuasion, et al.).
- 13.1.4 Develop appeals to the reader's logic, emotion, and ethics.
- 13.1.5 Demonstrate the five Cs of communication: clear, concise, correct, complete, coherent.

**14.0 Present information**

14.1 Present written information.

- 14.1.1 Identify reader(s)—demographics, number, etc.
- 14.1.2 Identify purpose—general and specific.
- 14.1.3 Format appropriate documents (letters, memoranda, assembly instructions, reports, and manuals).
- 14.1.4 Adapt information to the knowledge level of readers.
- 14.1.5 Apply revision techniques.
- 14.1.6 Employ standard English grammar and rules of mechanics, spelling, and punctuation.
- 14.1.7 Use computers to produce final draft.

14.2 Present oral information.

- 14.2.1 Analyze audience—demographics, size, setting, etc.
- 14.2.2 Identify purpose—general and specific.
- 14.2.3 Cite research material.
- 14.2.4 Adapt information to knowledge level of audience.
- 14.2.5 Use standard English grammar.
- 14.2.6 Demonstrate audience-centered techniques (eye contact, conversational tone, and others).
- 14.2.7 Respond to questions from audience.
- 14.2.8 Present information collaboratively as team members.

14.3 Present visual information.

- 14.3.1 Incorporate visuals effectively.
- 14.3.2 Dress in a professionally appropriate manner.

**15.0 Teaming skills and techniques**

15.1 Practice effective team skills.

- 15.1.1 Demonstrate the ability to work in teams.
- 15.1.2 Employ problem-solving skills to address a team task.
- 15.1.3 Employ workplace interpersonal skills, including conflict-resolution techniques.
- 15.1.4 Demonstrate listening skills.
- 15.1.5 Collaborate with others to obtain information.
- 15.1.6 Collaborate with others to develop and present written projects.
- 15.1.7 Collaborate with others to create and deliver oral presentations.

## Suggested Equipment List

**Project #1: Introduction to Technology Careers**

- Computer
- Office software
- Calculator
- Presentation system

**Project #2: Basic Hand Tools**

- Bicycle (single speed)
- Basic set of hand tools
- Meter stick and yard stick
- Tape measure
- Calipers

**Project #3: Mechanical Advantage**

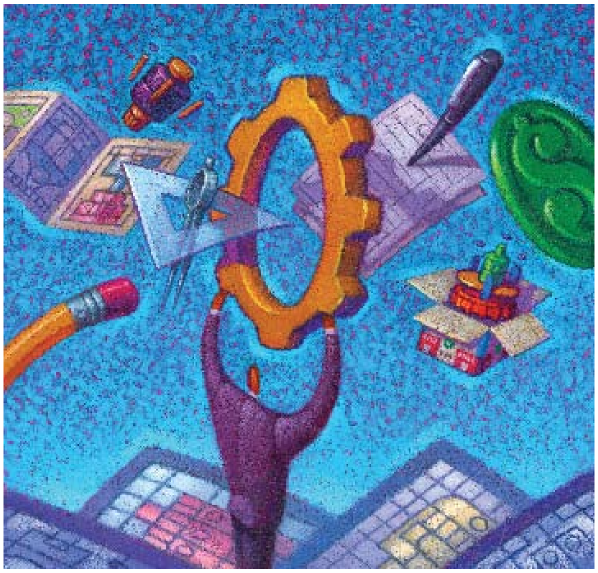
- Stopwatch
- Spring scales (lb. and/or Newton)
- Meter stick, knife edge, support stand
- Data logger for MBL (microcomputer-based laboratory)
- Force transducer for CBL (calculator-based laboratory) or MBL
- Protractors
- Balances
- Weights or masses
- Ramps, inclined planes, pulleys, wheels & axles, wedges, levers, screws
- Pulley cords
- Blank videotapes & video camera
- Video projector

**Project #4: Basic Electricity**

- Digital Multimeter
- Protoboard
- Resistors
- Wires
- Power supply
- Miniature lights
- Miniature light sockets
- CBL and MBL – voltage and current probes

**Project #5: Hydraulic Systems**

- Pressure gauges
- Pressure sensors for CBL and MBL
- Hydraulic cylinders
- Hydraulic pumps
- Hoses
- Ramps
- Weighted boxes
- Timers
- Linear measuring devices



# *Introduction to Technology Careers*

## Problem Scenario for the Student

Your team is in charge of communicating to high school juniors and seniors the occupational differences of industrial technologies using a brochure, videotape, web site, or written report. These high school students will need concise information about industrial programs such as industrial electronics technology (IEE), heating, ventilation, and air conditioning (HVAC), machine tool technology (MTT), and welding (WLD) to help them make suitable career choices. Information about job opportunities and career paths, salaries, physical ability requirements, education requirements, work environment, and other relevant information about these careers also should be included. To locate information about these occupations, your team should consult state and federal publications, on-line databases, professional journals, Student Success Centers, on-campus career centers, placement services, and other sources.

### Instructor Notes

1) Provide a good teaming environment for students with tables, easel pads, white boards, or other devices for organizing and recording team collaborative efforts.
2) Organize student teams. Students work best in teams of three to four students and benefit from participation in team meetings.
3) Explain and practice the problem-based learning (PBL) process. The use of a "Need-to-Know" chart (page 10) will reinforce the PBL process.
4) Provide sufficient time for students to complete this project. Completion dates may need to be extended. Periodic progress reports may be helpful.
5) Introduce computer applications such as spreadsheets and scientific/graphing calculators as good organizing and analyzing tools for students.
6) Use word processing and publishing tools to teach and reinforce basic communication skills.
7) Provide students access to the Internet and visits to the workplace to facilitate students' career research.
8) Facilitate students' career research by providing Internet access and workplace visits.

### Performance Expectations

- The faculty team will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Individual instructors will test and grade students on workshops and activities in their subject areas.
- The faculty team will evaluate and grade the product (brochure, report, videotape or web site).

### Objectives

Students will learn how to

- Research information about career options for technicians and develop a multimedia report (e.g., brochure, videotape, research report) suitable for high school juniors and seniors.
- Use computer software for page layout and design.
- Investigate and report information about technical career paths.

## Content Strands

### Mathematics
Order of operations
Spreadsheets
Charts and tables
Basic statistics

### Industrial Technology
Survey of industrial technology areas
Safety equipment
Proper work attire
Team-building skills

### Communications
Researching topics
Interviewing sources
Compiling a bibliography
Writing reports
Presenting information

## Student Training Topics
- Teaming in the workplace
- Workplace safety considerations
- Problem-based learning (PBL) process
- Calculator/computer skills
- Research/documentation techniques
- Basic statistics
- Designing tables, graphs, and other visuals
- Comparing and contrasting information
- Interviewing skills
- Presenting written information—designing a brochure, visuals, other media products

## Classroom Equipment
Computers -- 1 per 2 to 4 students
Office software
Word processing
Spreadsheets
Presentations
Scientific and/or graphing calculators

## Student Activities
Students will gather information through researching, through reading, and by interviewing people who work in the fields. They will investigate the following:
- On-campus industrial shops
- Job safety requirements
- Training/education requirements
- Recommended skills/knowledge
- Certification requirements
- Internships/apprenticeships
- Physical abilities (e.g., eye/hand coordination, ability to lift 50+ pounds)
- Technology job outlook—local, state, national
- Work area (inside/outside, large plant/small company, lab/office)
- Work clothes
- Salary ranges (comparison chart/graph)
- Career duties (e.g., assembling parts, studying blueprints, using machinery)
- Career fields/career paths
- Well-known people in career fields
- Pioneers in technical fields
- Titles of journals/magazines in technical fields
- Libraries and industries (visits)

## Classroom Resources

### Print

Barell, John (1998), *Problem-Based Learning, an Inquiry Approach,* Skylight Training and Publishing, Inc.
*Encyclopedia of Technology and Applied Sciences* (2000), Marshall Cavendish, Inc.
Fogarty, Robin (1997), *Problem-Based Learning: Other Curriculum Models for the Multiple Intelligences Classroom,* Skylight Training and Publishing, Inc.
Johnson, David W., and Roger T. Johnson (1996), *Meaningful and Manageable Assessment Through Cooperative Learning,* Interaction Book Company, Edina, MN.

### Non-Print

Access to computers and the Internet
Brochure templates available in office software
Department of Labor web site: www.dol.gov
Problem-based learning web site: http://www2.imsa.edu/programs/pbln/
South Carolina Employment Security Commission web site: www.sces.org
Videotapes from SC ATE lending library on web site: http://www.scate.org/Educators/FInfo/videolib.asp :
*Wealth, Innovation & Diversity*, Joel Barker & Paul Hopkins Productions, 31 minutes;
*Managing Diversity*, CRM Films, 23:15 minutes.

## Student Competencies for Project #1

| | |
|---|---|
| 1.1 | Perform basic calculator operations. |
| 3.1 | Evaluate algebraic expressions. |
| 3.2 | Solve linear equations. |
| 3.4 | Use spreadsheets to solve problems. |
| 5.1 | Collect, organize, and present quantitative and qualitative data. |
| 5.2 | Define and calculate measures of central tendency. |
| 5.3 | Present data graphically. |
| 11.1 | Practice lab/shop safety procedures. |
| 12.1 | Perform research in industrial fields to gather information. |
| 12.2 | Use non-print sources to gain information. |
| 13.1 | Apply basic information organizational techniques. |
| 14.1 | Present written information. |
| 14.3 | Present visual information. |
| 15.1 | Practice effective team skills. |

# Sample Rubric for Evaluating Project #1

**Industrial Core Project #1—Introduction to Technology Careers**

**STUDENT**________________________________________ **Date**________________________________________

| Point Value | Points Earned | | Needs Improvement | Proficient | Exceeds Requirements |
|---|---|---|---|---|---|
| 20 | _____ | **I. PROBLEM-SOLVING PROCESS** | | | |
| | | • developing need-to know chart | _______ | _______ | _______ |
| | | • gathering information | _______ | _______ | _______ |
| | | • analyzing data | _______ | _______ | _______ |
| | | • stating assumptions | _______ | _______ | _______ |
| | | • drawing conclusions | _______ | _______ | _______ |
| 60 | _____ | **II. CONTENT** | | | |
| | (20) _____ | **A. Technology** | | | |
| | | • industrial technology areas (heating and air conditioning, industrial electronics, welding) | _______ | _______ | _______ |
| | | • workplace safety skills | _______ | _______ | _______ |
| | (20) _____ | **B. Mathematics** | | | |
| | | • calculator skills | _______ | _______ | _______ |
| | | • spreadsheet skills | _______ | _______ | _______ |
| | | • charts and tables | _______ | _______ | _______ |
| | | • mean, median, mode | _______ | _______ | _______ |
| | (20) _____ | **C. Communication** | | | |
| | | • orginazation of presentation | _______ | _______ | _______ |
| | | • accurate and complete information | _______ | _______ | _______ |
| | | • appropriate format | _______ | _______ | _______ |
| | | • standard grammar and mechanics use | _______ | _______ | _______ |
| | | • clear and concise information | _______ | _______ | _______ |
| | | • effective visuals | _______ | _______ | _______ |
| 20 | _____ | **III. TEAMING SKILLS** | | | |
| | | • conflict resolution | _______ | _______ | _______ |
| | | • shared responsibilities | _______ | _______ | _______ |
| | | • self-evaluation | _______ | _______ | _______ |
| | | • peer and team evaluation | _______ | _______ | _______ |
| 100 | _____ | **TOTAL POINTS EARNED** | | | |

# Basic Hand Tools

## Problem Scenario for the Student

The Ready Ride Corporation has plans to set up a new production line to assemble bicycles. The maintenance department has been chosen to set up the new line. Directions for assembly and a list of needed tools do not currently exist. Due to insurance guidelines, only hand tools may be used. No power tools will be allowed.

Using available resources, your team is in charge of selecting the appropriate hand tools needed for the assembly of the bike. You will submit a set of written instructions and a list of needed tools for assembling the bike.

### Instructor Notes

1) Organize students into teams. Students work best in teams of three to four students and benefit from participation in team meetings.
2) Explain and practice the problem-based learning (PBL) process. The use of a Need-to-Know chart will reinforce the PBL process.
3) Provide a good teaming environment for students with tables, easel pads, whiteboards, or other devices for organizing and recording team collaborative efforts.
4) Provide students with access to the Internet and visits to the workplace.
5) Choose bikes that are less complicated.
6) Review a list of hand tools with students at the beginning of the project.

### Performance Expectations

- The faculty team will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Individual instructors will test and grade students on workshops and activities in their subject areas.
- The faculty team will evaluate and grade assembly instructions and tool lists.

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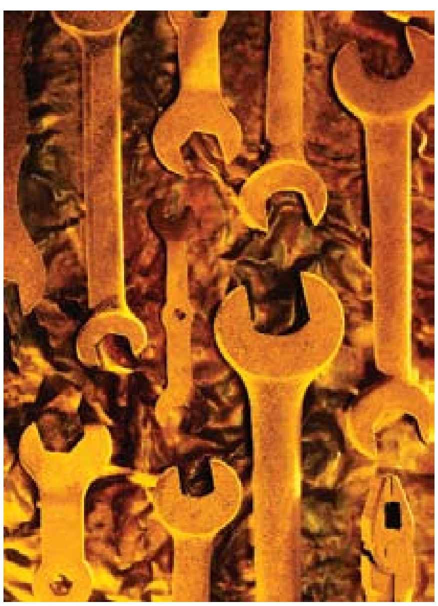
### Objectives

Students will learn how to

- Select appropriate hand tools for specific tasks.
- Write clear assembly instructions.
- Interpret assembly drawings.



## Content Strands

### Mathematics

Metric measurement (SI)
U.S. Customary measurement
Ratio and proportion
Tolerance
Fractional/decimal numbers
Precision/accuracy

### Industrial Technology

Workplace safety
Tool purpose and selection
Print reading
Measurement

### Communications

Dialoguing with team members
Gathering information
Interviewing sources
Presenting oral reports
Writing written reports

## Student Training Topics

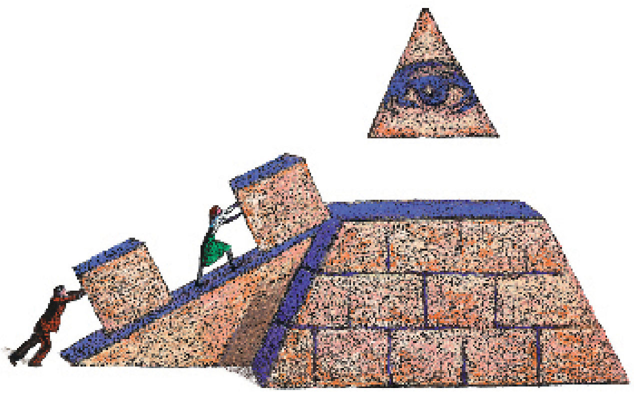
- Teaming skills
- Problem-based learning (PBL) process
- Characteristics of mechanical systems
- Comparing and contrasting information
- Relevant computer skills
- Presenting written information
- Assembly instructions
- Hand tools
- Measurement and measuring devices
- Print reading
- Ratio and proportion

## Classroom Equipment

- Hand tools
- Measuring devices
- Bicycles -- 1 per team
- Computers
- Calculators

## Student Competencies for Project #2

1.1 Perform basic calculator operations.
2.1 Define and use the SI system of measurement.
2.2 Perform linear two-dimensional and three-dimensional measurements.
3.1. Evaluate algebraic expressions.
10.1 Interpret basic blueprint symbols.
11.1 Practice lab/shop safety procedures.
11.2 Write logical procedural steps for preforming an assembly.
13.1 Apply basic information organizational techniques.
14.1 Present written information.
14.2 Present oral information.
14.3 Present visual information.
15.1 Practice effective team skills.



# Mechanical Advantage

## Problem Scenario for the Student

The plant's fork lift operator, D.A. Henry, drives off the concrete drive while trying to turn in the confined space. His forklift becomes stuck in the soft dirt surrounding the drive. D.A. comes to you to ask for your assistance in saving his job. You must help D.A. get the forklift back onto the concrete drive. Your team is in charge of determining the safest and most efficient method (e.g., come-along, chain fall, mechanical lift, inclined plane, etc.) of getting the forklift back onto the concrete pad.

### Instructor Notes

1) Organizie students in teams of three or four students, and the Problem-Based Learning (PBL) process (pages six and eight) should be continually reinforced.
2) Encourage students to build models of simple machines to generate test data.
3) Use technology (e.g., CBL/MBL) to gather physical data.
4) Be prepared to address student questions about physical constraints in the problem situation.
5) Use videotapes of student presentations as assessment tools.
6) Develop strong teaming skills by introducing topics such as consensus building.
7) Help students understand types of visuals, (e.g., transparencies, PowerPoint.).
8) Teach students about direct and inverse relationships.
9) Don't be too quick to answer all students' questions so students can learn through inquiry.
10) Facilitate students' understanding of the operating principles of equipment needed to solve the problem.

### Performance Expectations

- The faculty team will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Individual instructors will test and grade students on content lectures, labs, and activities.
- The faculty team will evaluate and grade the team product (report or other product).

### Objectives

Students will learn how to

- Investigate the mechanical advantage of simple machines, and devise a plan.
- Measure/calculate length, area, volume, and force in SI and U.S. Customary systems.
- Apply the conservation of energy to the operation of the simple machine.
- Determine the amount of work done by a simple machine.
- Develop a detailed safety report.

## Content Strands

### Mathematics

Basic measurements—SI and U.S. Customary systems
Data tables
Algebraic expressions
Geometric concepts
Area and volume
Solving equations
Direct and inverse relationships

### Industrial Technology

Random and systematic errors
Measurements
Mass and weight
Data collection (CBL/MBL)
Work
Simple machines
Workplace safety
Force

### Communications

Organizing information
Summarizing information
Formatting information
Incorporating visuals in presentations
Collaborating with team members
Writing reports and memos

## Student Training Topics

- Units and measurement (SI)
- Forces and motion (friction)
- Weight and mass
- Work, energy, and power
- Efficiency (work output vs. work input)
- Actual mechanical advantage vs. theoretical mechanical advantage
- Ratio and proportion
- Evaluating algebraic expressions and solving equations
- Right triangles
- Geometric concepts
- Area and volume
- Summarizing and formatting information
- Presenting information
- Collaboration and consensus building
- Process writing

## Classroom Equipment

- Spring scales (lb. and/or N)
- Force transducer for CBL or MBL
- Protractors
- Balances
- Calculators/computers
- Weights or masses
- Ramps, inclined plane, pulleys, wheel and axles, wedges, levers, and screws
- Meter sticks and rulers
- Support stands
- String/cord
- Surfaces (wood, rollers, sandpaper, etc.)
- Blank videotapes and video camera
- Video projector
- Stopwatch

## Student Activities

- Determine mechanical advantage
- Investigate pulley systems
- Investigate lever systems
- Investigate inclined planes
- Investigate work relationships

## Classroom Resources

**Web sites:**

**Lego**: http://www.lego.com/education/default.asp?page=4

**Caterpillar**: http://www.cat.com/cda/layout?m=37400&x=7

**John Deere**: http://www.deere.com/en_US/deerecom/equipment_quickfind/index.html

**CASE**: http://www.casece.com/index.asp?RL=NAE

# Classroom Activities for Mechanical Advantage Project #3

**1. Pulleys**

- Give a minilecture on mechanical advantage and work.
- Use guided discussion with the Problem-Based Learning (PBL) approach and Know/Need-to-Know (KNK) chart to determine quantities to measure to investigate a pulley system.
- Help students to set up a spreadsheet to aid in the analysis of pulley systems. Be sure to have students calculate the work done by the applied force and the work done on the weight to be moved.
- Investigate pulley systems by including several loads (three or more) for each pulley configuration and the force to lift. Be sure to measure the distance the load moves and the distance the applied force moves.
- Use guided discussions to analyze mechanical advantage and work.

**2. Levers**

- Use guided discussion with the PBL KNK approach to determine quantities to measure to investigate a lever system.
- Help students set up a spreadsheet to assist with the analysis of a lever system. Have the students calculate the work done by the applied force and the work done on the weights to be moved.
- Investigate lever systems by including several loads (three or more) for each load position and the force to lift it. Be sure to measure the distance the load moves and the distance the applied force moves.
- Help students determine the relationship between the applied force and the distance from the fulcrum and the weight and the distance from the fulcrum. These relationships to mechanical advantage should be discussed. Also discuss work relationships.

**3. Inclined Plane**

- Use guided discussion with the PBL KNK approach to determine quantities to measure to investigate an inclined plane.
- Help students set up a spreadsheet table to aid in the analysis of an inclined plane. Have students calculate the work done by the applied force and the work done on the weight to be moved.
- Investigate an inclined plane by including several loads (three or more) for each load position and the force to lift. Also, investigations should be made at several angles of the plane. Be sure to measure the distance the load moves and this distance the applied force moves.
- Help students determine the relationship between the applied force and the load and length of the hypotenuse and the height of the plane. Relate this to the mechanical advantage. Also discuss work relationships.

**4. Conservation of Energy**

- Compare the work done by the applied force and the work done on the load for all systems measured.
- Use guided discussion to introduce the concept of conservation of energy and its importance in problem solving.

## Student Competencies for Mechanical Advantage

| | |
|---|---|
| 2.1 | Define and use the SI system of measurement. |
| 2.2 | Perform linear two-dimensional and three-dimensional measurements. |
| 3.1 | Evaluate algebraic expressions. |
| 3.2 | Solve linear equations. |
| 4.1 | Apply the principles of geometric angles. |
| 4.2 | Recognize two-dimensional shapes. |
| 4.3 | Recognize three-dimensional shapes. |
| 4.4 | Determine perimeter, area, and volume. |
| 6.1 | Determine the relationships between the sides and angles of right triangles. |
| 7.1 | Apply simple machines. |
| 7.3 | Apply the use of weights and measures. |
| 11.1 | Practice lab/shop safety procedures. |
| 11.3 | Identify relevant experimental errors. |
| 11.4 | Distinguish between random and systematic errors. |
| 12.1 | Perform research in industrial fields to gather information. |
| 13.1 | Apply basic information organizational techniques. |
| 14.1 | Present written information. |
| 14.2 | Present oral information. |
| 15.1 | Practice effective team skills. |

# Basic Electricity

## Problem Scenario for the Student

After graduation, you and fellow team members have decided to open your own maintenance company. You are considering a building 20 feet wide and 30 feet long which would be used for all trades involved—machine tool, electrical, HVAC, and welding. Your task is to determine the equipment layout and electrical needs. The power company can supply only 120/240 single-phase current.

Your team will investigate the power requirements and develop a plan that will make the most effective use of the building space, yet still meet local codes. You will present a media presentation to your funding source and a comprehensive report describing the process necessary to complete the renovation, as well as any foreseeable problems.

### Instructor Notes

1) Have students conduct lab experiments in series and parallel circuits using ammeters and voltmeters.
2) Introduce voltage and current measurement using analog and digital measuring techniques. Use data collection with the CBL or MBL systems to reinforce computer usage.
3) Assign a student with electrical knowledge to each student team, if possible.
4) Invite a local building inspector to serve as a guest lecturer.
5) Organize a student tour of a maintenance shop facility in a local industry.


### Performance Expectations

- ♦ The faculty team will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- ♦ Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- ♦ Individual instructors will test and grade students on their understanding of lectures, labs, and activities.
- ♦ The faculty team will evaluate and grade team products (reports, presentations, or other objects).

### Objectives

Students will learn how to

- ♦ Interpret machine nameplate data.
- ♦ Gather and interpret information for code requirements (i.e., power company, inspectors)
- ♦ Investigate series and parallel circuits using volt, ohm, and amp meters.
- ♦ Use Ohm's law to determine a solution to a problem.
- ♦ Utilize the Internet to locate articles on industrial safety issues.
- ♦ Use a graphics/drawing program to create a scale layout of a building, equipment, and wiring.
- ♦ Follow appropriate safety measurements.
- ♦ Write a transmittal letter to a bank or other funding source.
- ♦ Write a process-based report.

## Content Strands

### Mathematics
Scientific & engineering notation
Algebraic expressions
Linear equations
Literal equations
Graphing techniques
Rational equations

### Industrial Technology
Electrical quantities/units
Voltage, current, power
Measure electrical quantities
Ohm's law
Power
Series & parallel circuits
Resistance

### Communications
Writing process reports
Writing letters
Researching electrical safety
Developing inquiry skills
Analyzing causal relationships
Writing formal reports

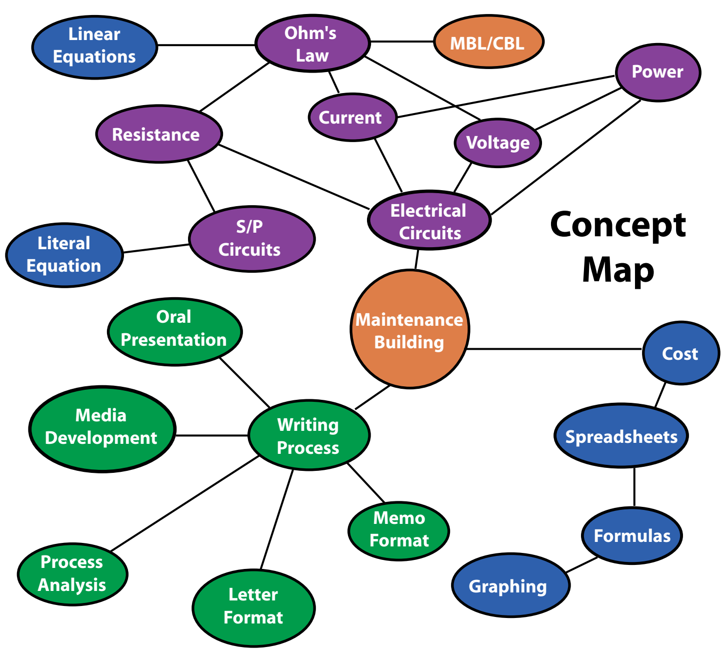
← Computer-based labs (MBL)
Calculator-based labs (CBL) →

## Student Training Topics

- Teaming skills
- Problem-based learning (PBL) process
- Characteristics of electrical circuits
- Comparing and contrasting information
- Relevant computer skills
- Presenting oral and written information
- Series and parallel circuits (lights and resistors)
- Ohm's law
- Graphing and interpretation of data
- Writing reports
- Writing letters

## Classroom Equipment

- Digital Multimeter
- CBL/MBL voltage and current probes
- Light bulbs (small 5 W and 7 W)
- Light sockets
- Wires
- Power supply DC/AC
- Protoboard
- Resistors




## Classroom Resources

**Books**


Arcaro, Jerome S. (1995), *Teams in Education: Creating an Integrated Approach,* St. Lucie Press, Delray Beach, Fl.

Cunningham, James B., and Norman Herr (1994), *Hands-On Physics Activities with Real-Life Applications: Easy-To-Use Labs and Demonstrations for Grades 8-12,* Center for Applied Research in Education, West Nyack, NY.

Laws, Priscilla (1997), *Workshop Physics Activity Guide*, John Wiley & Sons, New York.

*Unified Technical Concepts* (1990), Cord Communications, Waco, TX.

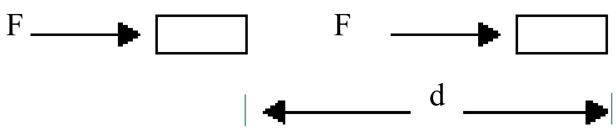

**Web Sites**

American Association of Physics Teachers:
http://www.aapt.org
Electrical codes and ordinances:
http://delapp.com/codes/

# Background Information

In a mechanical system, you have seen that the work done is the product of the force (F) applied in the direction of the motion and the distance (d) moved. Therefore, work (W) can be thought of as the product of a quantity that causes motion and the measure of the resulting motion.

$$W = Fd$$




This concept can be applied in an electrical system as well. The quantity that causes motion is the voltage difference and the measure of the motion is the charge. Therefore, work in an electrical system can be calculated by:

Work = (voltage difference) x charge

W = Vq, where
V = voltage difference and
q = charge

Electric motors transform electrical energy into mechanical energy to perform tasks. Motors may turn fans to move air; or operate pumps to move fluids. They also turn metal working machines such as lathes, mills, and drills. Therefore, the purpose of most electrical devices is to convert electrical work into other forms of work or energy, such as the energy of motion, heat, light, or sound.

The motion of charge through conductors will transform some of the electrical energy into heat. In devices such as toasters, ovens, and hair dryers, the heat is wanted and is useful. In other devices such as incandescent light bulbs, computers, and televisions, heat is an unwanted by-product caused by the operation of the device.

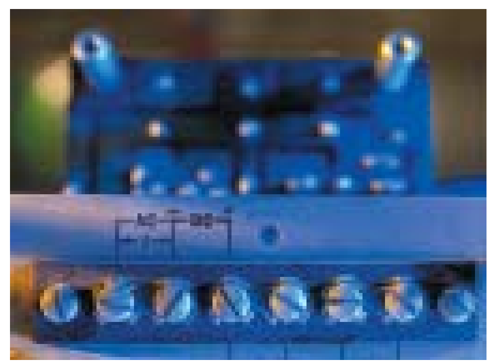
In electrical systems, the amount of electrical energy used is important. In fact, electric utilities bill customers according to the amount of energy used or consumed. In many electrical systems, however, that rate at which the energy is delivered is as important as the amount of energy used. All electrical devices are rated according to the rate they use energy. This rate is called power (P) and is measured in watts.

Power = work/time

Power = (voltage x charge)/time

Power = voltage x charge/time

Power = voltage x current



## Student Competencies for Project #4

1.1 Perform basic calculator operations.
2.1 Define and use the SI system of measurement.
3.1 Evaluate algebraic expressions.
3.2 Solve linear equations.
3.5 Use dimensional analysis to solve problems involving measurements.
7.2 Apply the basics of electricity.
11.1 Practice lab/shop safety procedures.
11.3 Identify relevant experimental errors.
11.4 Distinguish between random and systematic errors.
12.1 Perform research in industrial fields to gather information.
12.2 Use non-print sources to gain information.
13.1 Apply basic information organizational techniques.
14.1 Present written information.
14.2 Present oral information.
14.3 Present visual information.
15.1 Practice effective team skills.

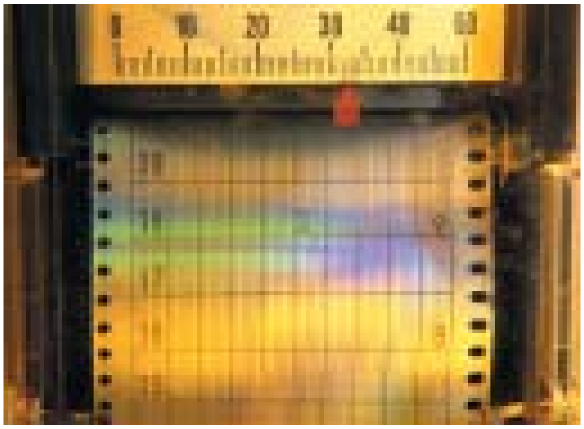
# Industrial Core Student Activities for Basic Electricity Project #4

### 1. Series and Parallel Circuits (Lights)

- Determine characteristics of series and parallel circuits by investigating the brightness of small miniature lamps (6.3 V) connected with series or parallel circuits.
- Give a minilecture on how to wire lamps to a power supply in series and parallel circuits.
- Use guided discussion to help students determine several configurations of series and parallel connection. Have students observe the lamp's brightness to determine the characteristics of series and parallel circuits. Help students develop a table to record the results. Students need only to record brightness with a subjective value (very bright, bright, dim, very dim).
- Give the students miniature lamps and miniature screw sockets (at least three) to connect as determined above.
- Require students to do all observations with the same voltage setting on the power supply.
- Use guided discussion to help students reach conclusions about series and parallel circuits.

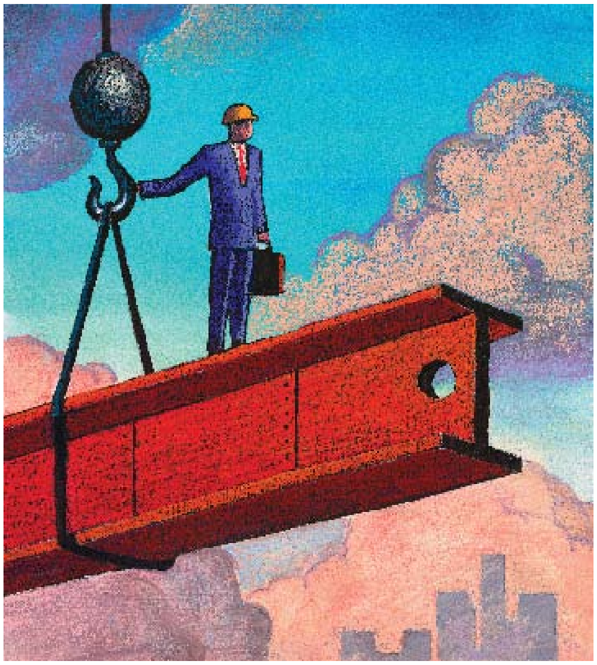
### 2. Series and Parallel Circuits (Resistors)

- Give a mini-lecture on measurement of voltage and current with a multimeter.
- Have students connect series and parallel circuits with resistors (use same value) and measure the voltage across each resistor and current through each resistor using the same configurations used with lights. Help students develop a table to record the results.
- Use guided discussion to help students reach conclusions about series and parallel circuits. Compare the conclusions with those for the light experiment.



### 3. Ohm's Law

- Give the students resistors with at least two different values of resistance.
- Have the students connect power supply, meters, and resistors to be able to measure the voltage across the resistors and the current through the resistors.
- Begin with low voltages from the power supply, and record the voltage and current. Make measurements with at least five different voltage settings of the power supply, and record the voltage and current.
- Plot the measurements for each resistor.
- Use guided discussion to help students discover the linear relationship between voltage and current and thus, observe Ohm's law.



# Hydraulic Systems

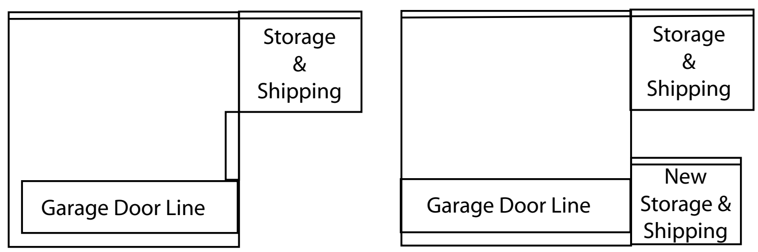
## Problem Scenario for the Student

Your company will be adding a new product line for automotive electronics, which will require the modifications of existing lines and the expansion of storage and shipping areas. Currently, the line for electronic controls for garage door openers packages the control circuit boards in shipping boxes and moves them to the storage and shipping area by a conveyor that runs the length of the plant. The current line now extends to the wall before making a right angle turn to move the boxes to the existing storage and shipping area. With the new line and the expansion, there will be a new storage and shipping area placed nearer to the garage door line.

### Instructor Notes

1) Set a target time for completion of the renovation.
2) Give students information about simple hydraulic systems.
3) Talk about the force needed to move an object up an inclined plane.
4) Review concepts and calculations involving mass, weight, density, volume, area and displacement.
5) Review mechanical advantage. (see Project #3 Mechanical Advantage)

**Diagram of storage and shipping area**




The plan is to cut a hole in the wall that will allow the boxes from the garage door line to move into the new storage and shipping area. Unfortunately, there are electrical, water, and HVAC services in the wall that extend 40 inches above the floor. The garage door assembly line is 30 inches above the floor.

Several teams will be looking at ways to move the boxes over the wall and to the floor of the storage area. Your maintenance team has been asked to develop plans to move the boxes from the garage door line over the service utilities and to the floor of the new storage and shipping area given the following criteria:

- Use the existing hydraulic system on the garage door line.
- Do not alter the utilities on the wall between the assembly line and the storage and shipping area.
- Develop at least two solutions for how to move the boxes safely to the floor in the storage and shipping area.
- Select the best solution for moving the boxes.
- Prepare a drawing of your solution.
- Determine the cylinder size needed to move the boxes.
- Make some modifications to the end of the assembly line.

The existing hydraulic pump will supply a pressure of 700 pounds per square inch (psi) with a flow rate of 10 gallons per minute. The system now has four cylinders. Two of the cylinders are ½ inches in diameter and move 2 inches. The other two are ¾ inches in diameter and move 1½ inches.

## Performance Expectations

- Instructors will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Students will search the Internet for sites related to hydraulic and mechanical systems.
- Individual instructors will test and grade students individually on content lectures, labs, and activities.
- The faculty team will evaluate and grade the team report (proposal and drawings).

## Objectives

Students will learn how to
- Determine the size of the hydraulic cylinder to be installed.
- Use pressure-measuring devices and measuring tools (tape, rule, calipers, micrometer, lift).
- Investigate the operation of a simple hydraulic system, and relate the cylinder sizes to mechanical advantage.
- Determine the list of tools and materials required to complete the project.
- Write a formal report or proposal with solutions and recommendations.

## Classroom Equipment

- Pressure gauge
- Computer
- Pressure sensors
- Calculator
- Calipers
- Hydraulic jacks

## Student Training Topics

- Safety
- Pressure and pressure measurements
- Pressure units and conversions
- Review mass, weight, force, and density
- Volume and area calculations
- Teaming techniques
- Hydraulic systems, including jacks
- Reading, sketching, and interpreting blueprints
- Mechanical advantage
- Displacement of a cylinder
- Review basic algebraic equations
- Rate (production flow and displacement)
- Writing proposals

## Content Strands

### Mathematics

Algebraic equations
Estimating
Volume & area calculations
Trigonometry

### Industrial Technology

Pressure & pressure measurements
Hydraulic systems
Mass, weight, force, & density
Rate (production flow and displacement)

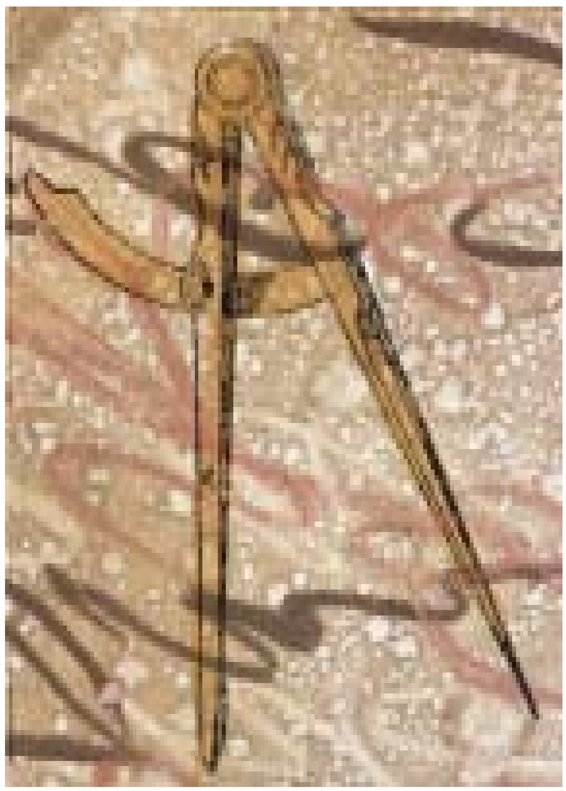
### Communications

Working in teams
Writing proposals
Communicating orally
Communicating in writing

## Student Competencies for Project #5

| | |
|---|---|
| 3.3 | Evaluate exponential expressions. |
| 3.5 | Use dimensional analysis to solve problems involving measurements. |
| 4.3 | Recognize three-dimensional shapes. |
| 4.4 | Determine perimeter, areas, and volume. |
| 8.1 | Apply the principles of hydraulics. |
| 9.1 | Define and calculate speed as the rate of time change over a particular distance. |
| 9.2 | Define and calculate production rate. |
| 10.1 | Interpret basic blueprint symbols |
| 10.2 | Sketch/draw diagrams for mechanical systems. |
| 12.1 | Use non-print sources to gain information |
| 13.1 | Apply basic information organizational techniques. |
| 14.1 | Present written information. |
| 14.2 | Present oral information |
| 14.3 | Present visual information. |
| 15.1 | Practice effective team skills. |

# Student Handouts



## Student Handout: Industrial Core Project #1

# *Introduction to Technology Careers*

### Problem Scenario

Your team is in charge of communicating to high school juniors and seniors the occupational differences between industrial technologies using a brochure, videotape, web site, or written report. These high school students will need brief information about industrial programs such as industrial electronics technology (IEE), heating, ventilation, and air conditioning (HVAC), machine tool technology (MTT), and welding (WLD) to help them make suitable career choices. Information about job opportunities and career paths, salaries, physical-ability requirements, education requirements, work environment, and other relevant information about these careers also should be included. To locate information about these occupations, your team should consult state and federal publications, online databases, professional journals, student success centers, on-campus career centers, placement services, and other sources.

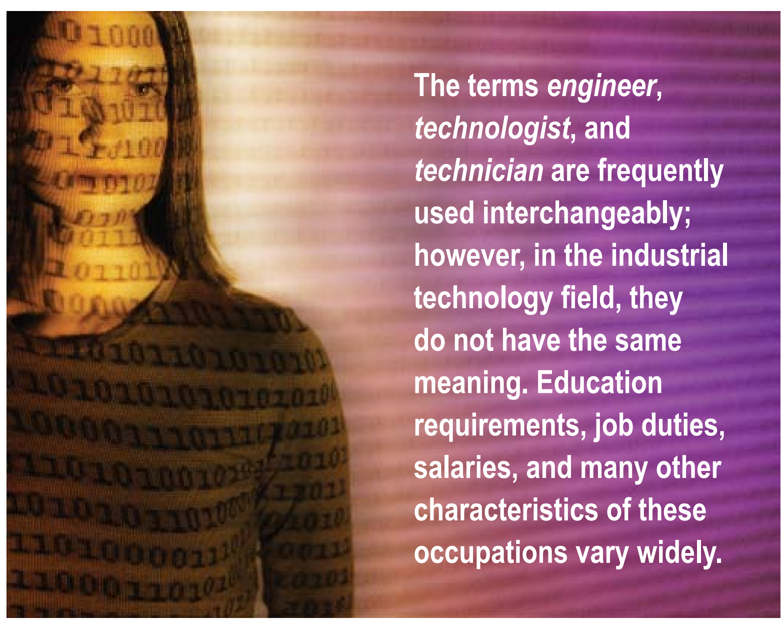
### Objectives

Students will learn how to

- ♦ Research information about career options for technicians and develop a multimedia report (e.g., brochure, videotape, research report) suitable for high school juniors and seniors.
- ♦ Use computer software for page layout and design.
- ♦ Investigate and report information about technical career paths.

### Performance Expectations

- ♦ The faculty team will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- ♦ Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- ♦ Individual instructors will test and grade students on workshops and activities in their subject areas.
- ♦ The faculty team will evaluate and grade the team product (brochure, report, videotape or web site).



## Student Handout: Industrial Core Project #2

# Basic Hand Tools

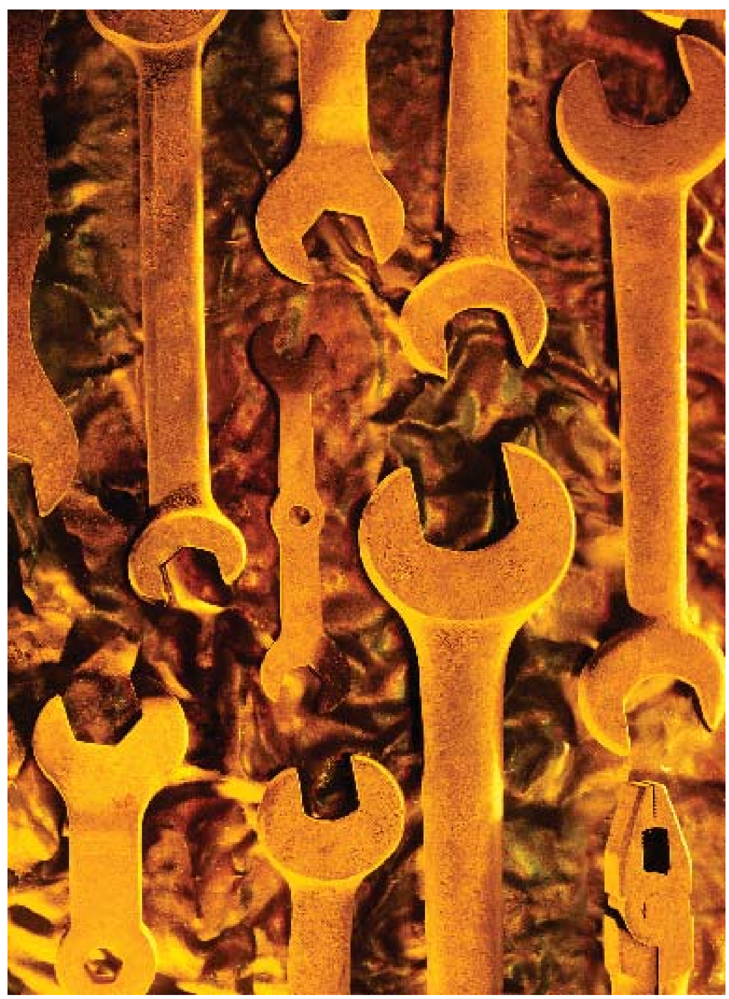
### Problem Scenario

The Ready Ride Corporation has plans to set up a new production line to assemble bicycles. The maintenance department has been chosen to set up the new line. Directions for assembly and a list of needed tools do not currently exist. Due to insurance guidelines, only hand tools may be used. No power tools will be allowed.

Using available resources, your team is in charge of selecting the appropriate hand tools needed for the assembly of the bike. You will submit a set of written instructions and a list of needed tools for assembling the bike.

### Objectives

Students will learn how to
- Select appropriate hand tools for specific tasks.
- Write clear assembly instructions.
- Interpret assembly drawings.

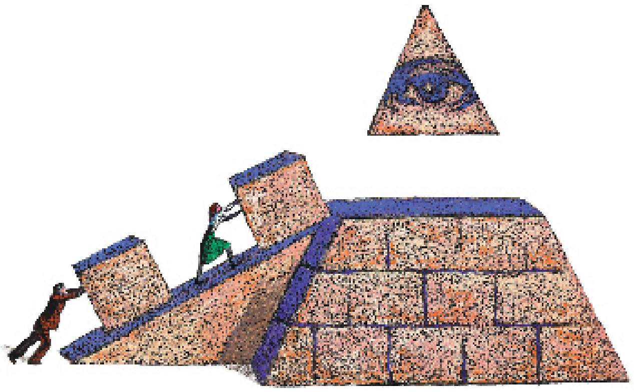


### Performance Expectations

- Faculty teams will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Individual instructors will test and grade students on workshops and activities in their subject areas.
- Faculty teams will evaluate and grade assembly instructions and tool list.

## Student Handout: Industrial Core Project #3

# Mechanical Advantage



## Problem Scenario

The plant's fork lift operator, D.A. Henry, drives off the concrete drive while trying to turn in the confined space. His forklift becomes stuck in the soft dirt surrounding the drive. D.A. comes to you to ask for your assistance in saving his job. You must help D.A. get the forklift back onto the concrete drive. Your team is in charge of determining the safest and most efficient method (come-along, chain fall, mechanical lift, inclined plane, etc.) of getting the forklift back onto the concrete pad.

### Objectives

Students will learn how to

- Investigate the mechanical advantage of simple machines, and devise a plan.
- Measure/calculate length, area, volume, and force in SI and U.S. Customary systems.
- Apply the conservation of energy to the operation of the simple machine.
- Determine the amount of work done by a simple machine.
- Develop a detailed safety report.

### Performance Expectations

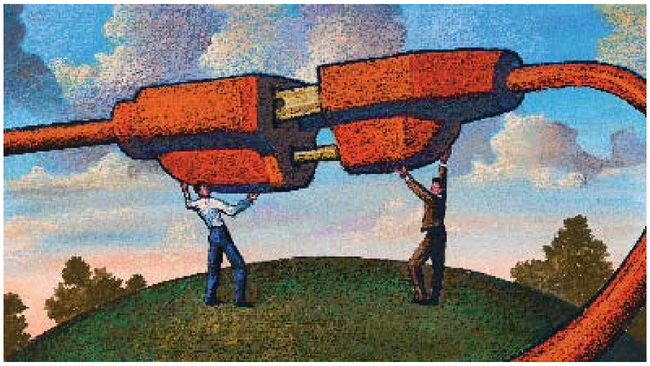
- The faculty team will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Individual instructors will test and grade students on content lectures, labs, and activities.
- The faculty team will evaluate and grade the team product (report or other product).

*A general misconception is that machines can decrease the amount of work required to complete a specific task. Work in science deals with force and distance.*

*Even though holding a five-gallon bucket full of water may be difficult, you are not doing work in science because no distance is involved. When you lift or move the bucket, however, you are doing work.*

*We find that machines can only make the work we do easier, but they can never decrease the work that we do. In industry, having an understanding of work and simple machines allows us to use these devices efficiently without wasting energy.*

## Student Handout: Industrial Core Project #4



# Basic Electricity

## Problem Scenario

After graduation, you and fellow team members have decided to open your own maintenance company. You are considering a building 20 feet wide and 30 feet long which would be used for all trades involved—machine tool, electrical, HVAC, and welding. Your task is to determine the equipment layout and electrical needs. The power company can supply only 120/240 single-phase current.

Your team will investigate the power requirements and develop a plan that will make the most effective use of the building space, yet still meet local codes. You will present a media presentation to your funding source and a comprehensive report describing the process necessary to complete the renovation, as well as any foreseeable problems.

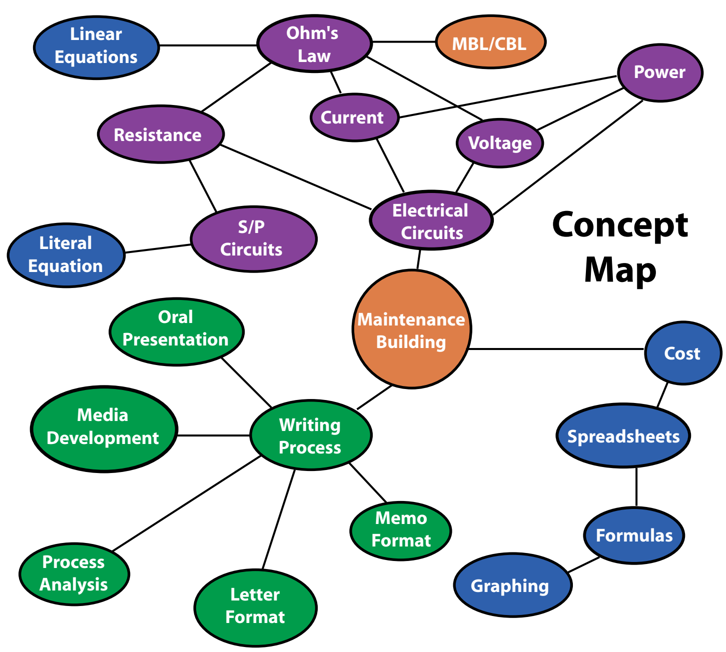
### Objectives

Students will learn how to

- Interpret machine nameplate data.
- Gather and interpret information for code requirements (e.g., power company, inspectors)
- Investigate series and parallel circuits using volt, ohm, and amp meters.
- Use Ohm's law to determine a solution to a problem.
- Utilize the Internet to locate articles on industrial safety issues.
- Use a graphics/drawing program to create layout (building, equipment, and wiring) to scale.
- Follow appropriate safety measurements.
- Write a transmittal letter to the bank or other funding source.
- Write a process-based report.

### Performance Expectations

- The faculty team will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Individual instructors will test and grade students on their understanding of lectures, labs, and activities.
- The faculty team will evaluate and grade student teams' products (reports, presentations, or other objects).

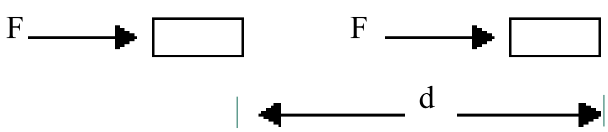


## Student Handout: Industrial Core Project #4, page 2

# Background Information

In a mechanical system, you have seen that the work done is the product of the force (F) applied in the direction of the motion and the distance (d) moved. Therefore, work (W) can be thought of as the product of a quantity that causes motion and the measure of the resulting motion.

$$W = Fd$$



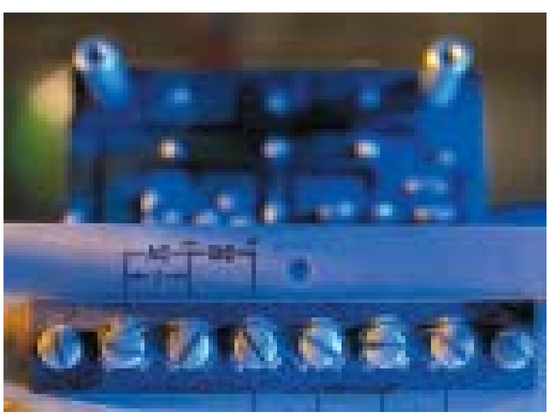

This concept can be applied in an electrical system as well. The quantity that causes motion is the voltage difference and the measure of the motion is the charge. Therefore, work in an electrical system can be calculated by:

Work = (voltage difference) x charge

W = Vq, where
V = voltage difference and
q = charge

Electric motors transform electrical energy into mechanical energy to perform tasks. Motors may turn fans to move air, operate pumps to move fluids, and turn metalworking machines such as lathes, mills, and drills. Therefore, the purpose of most electrical devices is to convert electrical work into other forms of work or energy, such as energy of motion, heat, light, or sound.

The motion of charge through conductors will transform some of the electrical energy into heat. In devices such as toasters, ovens, and hair dryers, the heat is wanted and is useful. In other devices such as an incandescent light bulb, computers, and televisions, the heat is an unwanted by-product caused by the operation of the device.



In electrical systems, the amount of electrical energy used is important. In fact, the bills that we receive from the electric company are based on the energy that we use. In many electrical systems, however, not only is the energy used important, but so is the rate at which the energy is delivered. All electrical devices are rated on the rate of use of electrical energy. This rate is called power (P) and is measured in watts.

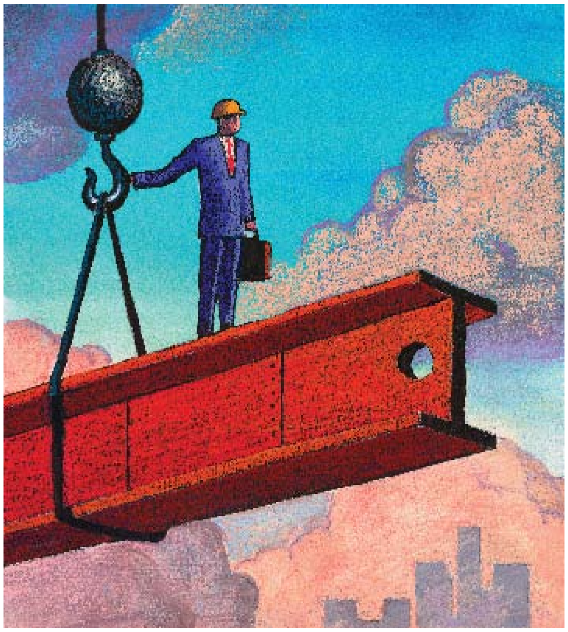
Power = work/time

Power = (voltage x charge)/time

Power = voltage x charge/time

Power = voltage x current

## Student Handout: Industrial Core Project #5



# *Hydraulic Systems*

## Problem Scenario

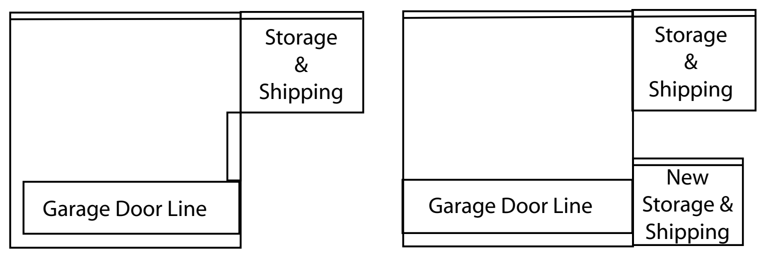
Your company will be adding a new product line for automotive electronics, which will require the modifications of existing lines and the expansion of storage and shipping areas. Currently, the line for electronic controls for garage door openers packages the control circuit boards in shipping boxes and moves them to the storage and shipping area by a conveyor that runs the length of the plant. The current line now extends to the wall before making a right angle turn to move the boxes to the existing storage and shipping area. With the new line and the expansion, there will be a new storage and shipping area placed nearer to the garage door line.

### Objectives

Students will learn how to

- Determine the size of the hydraulic cylinder to be installed.
- Use pressure-measuring devices and measuring tools (tape, rule, calipers, micrometer, lift).
- Investigate the operation of a simple hydraulic system, and relate the cylinder sizes to mechanical advantage.
- Determine list of tools and materials required to complete project.
- Write a formal report or proposal with solutions and recommendations.

**Diagram of storage and shipping area**




The plan is to cut a hole in the wall that will allow the boxes from the garage door line to move into the new storage and shipping area. Unfortunately there are electrical, water and HVAC services in the wall that extend 40 inches above the floor. The garage door assembly line is 30 inches above the floor.

Several teams will be looking at ways to move the boxes over the wall and to the floor of the storage area. Your maintenance team has been asked to develop plans to move the boxes from the garage door line over the service utilities and to the floor of the new storage and shipping area given the following criteria:

- You are to use the existing hydraulic system on the garage door line.
- You may not alter the utilities on the wall between the assembly line and the storage and shipping area.
- You should develop at least two solutions for how to move the boxes safely to the floor in the storage and shipping area.
- You will select the best solution for moving of the boxes.
- You will prepare a drawing of your solution.
- You will determine the cylinder size needed to move the boxes.
- You can make some modifications to the end of the assembly line.

The existing hydraulic pump will supply a pressure of 700 psi with a flow rate of 10 gal per minute. The system now has four cylinders. Two of the cylinders are ½ inches in diameter and move 2 inches. The other two are ¾ inches in diameter and move 1½ inches. The current production rate of the line is such that one box is filled every 30 seconds. Each box weights 220 pounds.

# Student Handout: Industrial Core Project #5, page 2

## Background Information

A fluid is a liquid or gas that must be confined to a container. Liquids will conform to the shape of the container, but will have the same volume for all containers. Gases will conform to the shape of the container and will have the volume of the container. Therefore, gases must be in a closed system and liquids may or may not be in closed system. The term *hydraulic* is used to refer to a liquid and *pneumatic* is used to refer to a gas.

One of the important measurements for a fluid is pressure. Pressure is defined as the force per unit area and is exerted through out the fluid. When there is a pressure difference between two points in a fluid, the fluid will flow from high pressure to low pressure. If the fluid is static, the pressure will be the same throughout the fluid. This is known as Pascal's law.

For fluids with a large depth, such as water in a lake or ocean or the air around us, the pressure is due to the weight of the fluid above the point at which the pressure is measured. For the air around us, the pressure is called atmospheric pressure. It is:

1 atmosphere = 14.7 lb per $in^2$ (psi)
= $1.013 \times 10^5$ Newton/meters$^2$ ($N/m^2$)
= 33.92 ft of $H_2O$
= 760 mm of Mercury (Hg)
= 29.92 in of Hg

Many times pressure is measured as the pressure above atmospheric. This is called *gage pressure*. The total pressure or *absolute pressure* is:

Total pressure = gage pressure + atmospheric pressure

## Performance Expectations

- The faculty team will evaluate student team performance and individual student performance on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Students will search the Internet for sites related to hydraulic and mechanical systems.
- Individual instructors will test and grade students on content lectures, labs, and activities.
- The faculty team will evaluate and grade the team report (proposal and drawings).

# NOTES

# NOTES

**SCATE Inc.**
**South Carolina Advanced Technological Education (SCATE) Center of Excellence**
**Florence-Darlington Technical College**
**Florence, South Carolina**

Elaine L. Craft, Center Director and Principal Investigator
Dr. Helen S. Edens, Special Projects Manager
Dr. James C. Wood, Special Projects

Sharon Needham, Graphic Designer

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Greenwood, South Carolina

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