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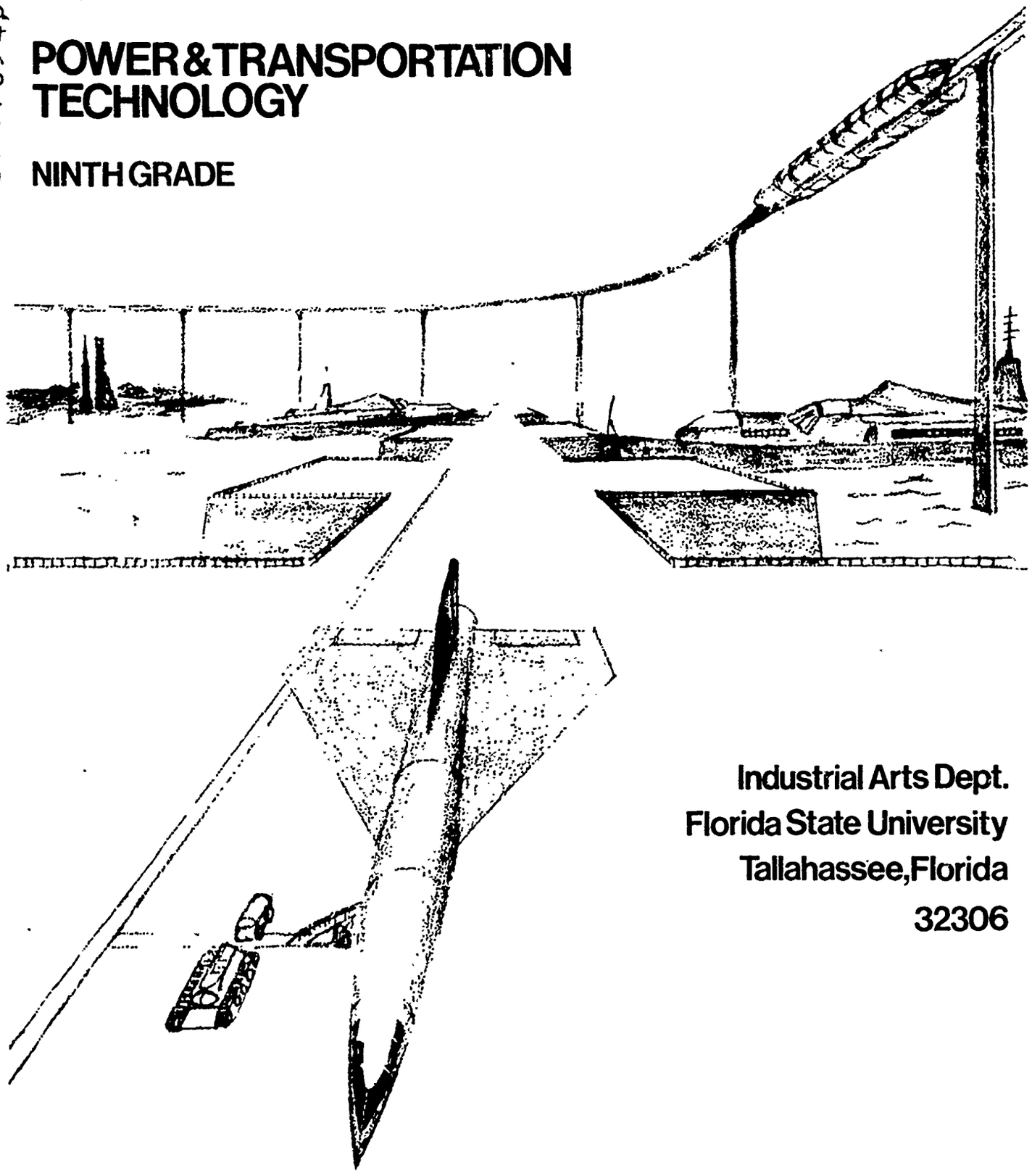
ABSTRACT

This publication is a curriculum guide for conducting courses in power and transportation technology, and was prepared as a result of a Summer 1972 workshop. The courses suggested herein are recommended for the ninth grade level. Keeping in mind the different amount of time available in different institutions for such courses, the publication outlines two courses, one of which runs for a semester (90 hours) and the other for one year (180 hours). Course outlines are provided for both of these programs. In each section, brief outlines are given first, arranged according to topics and subtopics. Examples are given for organizing the materials on these brief outlines, and the manner in which these should be taught in classrooms. Laboratory activities with explanations are suggested as motivational techniques. A separate and detailed section is included providing information about jobs available. For each professional, skilled and unskilled job, minimum educational qualifications, job descriptions and other related information are provided. Information is also provided for equipment purchase and workshop lay-out plans. (PS)

Recommended Curriculum Guide

POWER & TRANSPORTATION TECHNOLOGY

NINTH GRADE



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RECOMMENDED CURRICULUM GUIDE

FOR NINTH GRADE COURSE

IN POWER & TRANSPORTATION TECHNOLOGY

Prepared by

Power & Transportation Workshop Participants

Summer, 1972

Submitted to the State of Florida
Department of Vocational, Technical
and Adult Education

by

Industrial Arts Department
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INTRODUCTION

Man has always wondered at the phenomena of power as part of his environment. However, only in the last 250 years has man developed the technology with which he could fully explore the vastness of this dimension effectively.

The internal combustion engine has become a trusted and valuable servant of the American people. During the past few years engineering design and manufacturing skills have made the modern engine simple to operate and economical to maintain. At the same time, improvements in manufacturing techniques have made it possible to use better materials and closer tolerances so that engine life has been tremendously increased. Today, engines serve us in all manner of jobs and in all types of environments.

With advancing technology came new types of energy systems. Therefore, this guide will emphasize the newer concepts of mechanical, electrical and fluid power systems; such as rocket propulsion, fuel cells and fluidics.

One of the prime uses of power today is the field of aerospace. Man through his advancing technology, has developed the power to escape the gravitational pull of the earth and hurl himself through space at tremendous speeds. He has devised many new power sources by which he can meet his needs in space as well as on earth. Therefore, a course of study in power and transportation technology has to include a study of man's use of power in space and its transference to earth applications.

Such was the purpose of the State Department of Education sponsored Summer 1972 Workshop in Power & Transportation Technology - to acquaint teachers with "State of the Art" equipment, techniques as well as updated career information associated with the Power & Transportation Industries. With this purpose in mind, this suggested curriculum guide has been prepared to provide teachers with detailed planning information for two specific time frames at the 9th grade level.

They are:

1. An 18-week, 90-hour, junior high or middle school program in power & transportation technology.
2. A 36-week, 180-hour, junior or middle school program in power & transportation technology.

It is intended that the curriculum outline serve as a suggested schedule of instructional activities for power teachers. Many suggested materials and motivational ideas are presented for the guidance of teachers to aid them in the task of equipping, planning and instructing an updated course in this important area.

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Participating Manufacturers of "State of the Art" Equipment

d.c. Jaeger Corp.
1010 Executive Center Dr.
Orlando, Florida

Scott Engineering Sciences Inc.
1400 S.W. 8th St.
Pompano Beach, Florida

Other cooperating organizations:

U.S. Naval Engine Rework Center
Naval Air Station
Pensacola, Florida

Kinetics, Inc.
Sarasota, Florida

Briggs & Stratton Company
Milwaukee, Wisconsin

Cover: Randy Newton

SECTION B

Topical Course Outline

& Typical Resource Units (Semester Program)

Mechanical, Electrical &

Fluid Power

Transportation Technology

MECHANICAL POWER

HISTORY OF MECHANICAL POWER

I. History of Power Development
   A. Simple and Compound Machines
      1. Mechanical advantage
      2. Lever, wheel and axle, inclined plane, wedge, pulley, screw
      3. Compound machines
   B. Applications of water power
      1. River flow
         a. Barge
         b. Waterwheel
         c. Hydroelectric
      2. Ocean flow
         a. Barge
         b. Tidal
      3. Future
   C. Applications of wind power
      1. Windmills-grinding
      2. Sailboats
      3. Prarie schooners
      4. Windmills-electric
      5. Future

WORK, ENERGY AND POWER

II. Work
   A. Definition
   B. Work as related to force and distance
   C. Measurement
III. Energy
   A. Definition
      1. Potential energy
      2. Kinetic energy
   B. Law of the conservation of energy
IV. Power
   A. Definition
   B. Measurement
   C. Horsepower
      1. Definition
      2. Measurement

COMBUSTION AND EXPANSION OF SOLIDS AND GASES

I. Combustion
   A. Definition
   B. Elements needed
      1. Fuel
      2. Heat

C. Internal Combustion Engines
    1. Principles
        a. Two stroke cycle
        b. Four stroke cycle

FUELS & LUBRICANTS

I. Petroleum Fuels
    A. Types of fuel
    B. Methods of fuel rating
II. Lubricating Oils
    A. Development of engine oils
    B. Characteristics of engine oils
    C. Use of engine oils
III. Greases
    A. Types & characteristics
    B. Application
IV. Laboratory Experiences (See Resource Units)

EXTERNAL COMBUSTION CONVERTERS

I. Reciprocating Steam Engines
    A. The function of a steam engine
    B. The history of the early development of the steam engine and its developers.
    C. Basic parts and principles of a steam engine
    D. Basic parts and assembly of a vertical reciprocating steam engine
    E. Past and present uses of the reciprocating steam engine
II. Steam Generator
    A. Boilers
        1. Water tube
        2. Fire tube
    B. Fuels
    C. Feed water heaters
    D. Super heaters
    E. Safety and control devices
III. Steam Turbines
    A. Present day uses
    B. Basic kinds of steam turbines
        1. Impulse turbine
        2. Reaction turbine
    C. Cycles
        1. Reheat
        2. Regenerative
    D. Variations of steam engines
        1. Noncondensing turbine
        2. Back-pressure turbine
        3. Extraction turbine

E. Speed governors
   1. Nozzle type
   2. Throttle type

RECIPROCATING TYPE CONVERTERS

III. Construction of the Small Gasoline Engine
   A. Basic engine parts
      1. Crankcase, block, head
      2. Cylinder, piston, connecting rod, crankshaft,
   B. Four stroke cycle engine
   C. Two stroke cycle engine
IV. Engines Systems
   A. Fuel systems
      1. Pumps
      2. Carburetors
         a. Gravity
         b. Suction
         c. Pressure tank
         d. Pump
      3. Governors
         a. Air vane
         b. Mechanical
         c. Pneumatic
   B. Lubrication four cycle
      1. Splash
      2. Ejection pump
      3. Barrel pump
      4. Full pressure
   C. Cooling systems
      1. Air
      2. Water
   D. Ignition systems
      1. Electron theory

THE COMPRESSION IGNITION ENGINE

I. Characteristic of compression engine
   A. Absent of spark plugs
   B. Absent of distributor
   C. Absent of coil
   D. Present of air injection
   E. Absent of a carburetor
   F. Compression ratio
II. Fuel injection system
   A. Air injection
   B. Spraying of diesel oil
   C. Mixture of air and fuel
   D. Fuel in cylinder
   E. Fuel burning
   F. Piston position

III. Starting systems
  A. Cranking of small engine
  B. Switching on large engine from small engine
  C. Shut off small engine
IV. Application of compression ignition engine
  A. Two -stroke cycle diesel
    1. Air blown through intake ports
    2. Fuel enters cylinder through injector
    3. Fuel ignition and temperature
    4. Opening of exhaust valves
    5. Entering of new air
  B. Four stroke cycle diesel
    1. Entering air
    2. Fuel entering
    3. Ignition by compressed air
    4. Exhaust gases pressed by piston
    5. Air blower
    6. Roots blower
    7. Turbocharger
  C. Diesel fuel production
    1. Cast
    2. Cast difference in gasoline and diesel fuel
    3. Burning and deposits
    4. Piston movement

TRANSMISSION OF POWER

I. Types of belt drives
  A. V-belt
    1. Uses
    2. Characteristics
  B. Ribbed belt
    1. Uses
    2. Characteristics
  C. Round
    1. Uses
    2. Characteristics
  D. Flat
    1. Uses
    2. Characteristics
II. Characteristics of belts in general
  A. Efficiency
  B. Size and shape
  C. Reinforcing materials
  D. Physical principles involved
III. Applications (transmit power)
  A. Cover applications as outlined in the Topical Outline.

Subject Matter Outline: (Second class period)
I. Review previous day's lecture
II. Laboratory activity

EMERGING NEW ENGINE DESIGNS

I. Wankel rotary-combustion engine
   A. Principles of operation
   B. Component systems
      1. Lubrication
      2. Combustion
      3. Cooling
      4. Ignition

II. Free piston engine
   A. Freon engine
      1. Development
      2. Principle of operation
   B. Ion engine
      1. Principle of operation
      2. Application

III. Gas turbine engine
   A. Development of the gas turbine
      1. The Holzworth gas turbine
      2. Exhaust gas turbines
      3. Turbo compressors
   B. Principles of operation
   C. Types of turbines
      1. Centrifugal compressor type
      2. Axial compressor type
      3. Gas generator type
   D. Applications
      1. Vehicular
      2. Boat
      3. Stationary power plants

IV. Gas turbine reaction engines
   A. Jet engine development
      1. The aeolipile
      2. Ram jet
      3. Pulse jet
      4. Ion jet
      5. Arc jet
   B. Design and structure
      1. Inlet ducts
      2. Compressors
      3. Combustion chambers-mixing chambers
      4. Bearings
      5. Exhaust nozzles-jet orifices
   C. Accessory systems
      1. Oil systems
      2. Electrical systems
      3. Fuel systems
      4. Supercharger systems
      5. Starting systems
   D. Afterburners
      1. Principles of operation
      2. Construction
      3. Control systems

E. Application
    1. Pulse jet - subsonic flight
    2. Ram jet - supersonic flight

V. Rocket engines
    A. Development
    B. Types
        1. Liquid fueled
        2. Solid fueled
        3. Nuclear
    C. Application
        1. Space travel
        2. Weather predicting
        3. Military surveillance

ELECTRICAL POWER

CONVENTIONAL ELECTRICAL CONVERTERS

I. Basic effects of electric current
   A. Magnetic effect
      1. Electromagnets
      2. Relays
      3. Electric bells and buzzers
      4. Motors
      5. Meters
   B. Chemical effect
      1. Electrolysis
      2. Battery charging
      3. Electroplating
      4. Anodizing
      5. Electroforming
   C. Heating effect
      1. Light bulbs
      2. Toasters
      3. Irons
      4. Electric heaters
   D. Physiological effect
      1. Electric fences
      2. Electric prods
      3. Electrotherapy
      4. Electric chair

II. Electrical terms
   A. Voltage
      1. Is electric pressure
      2. Unit of measure: Volts (V)
   B. Amperage
      1. Is current flow
      2. Unit of measure: Amperes (I)
   C. Resistance
      1. Is opposition to current flow
      2. Unit of measure: Ohms ( )

III. Equipment for electrical measurements
   A. Types of equipment
      1. Voltmeter
      2. Ammeter
      3. Ohmmeter
      4. Combination meter
   B. Use of equipment

IV. Current-carrying ability of materials
   A. Dependent on type of material
      1. Conductors---MUCH
      2. Insulators---EXTREMELY LITTLE
      3. Resistors--- SOME
   B. Dependent on physical variables
      1. Size (cross-section)
      2. Length
      3. Temperature (ordinarily negligible)

V. Five ways of producing current electricity
   A. Magnetic field and conductor

B. Chemical action
C. Heat (thermoelectric effect)
D. Pressure (piezoelectric effect)
E. Light (photoelectric effect)

VI. Two types of current electricity
A. Direct current (D.C.)
B. Alternating current (A.C.)

VII. Electrical circuits
A. Definition of a circuit
B. Types of connections
1. Series
2. Parallel
3. Series-parallel

VIII. Circuit calculations
A. Ohm's Law
B. Watt's Law

THE NATURE OF MAGNETISM

I. Principals and properties of magnets and magnetic forces.
A. Magnet
B. Magnetic poles
C. Basic Law of magnetism
D. Types of magnets
E. Use of magnets
F. Make a magnet

II. Principals and applications of electromagnets
A. Electromagnet
B. Magnetic field around current-carrying conductor
C. Left hand rule
D. Electromagnetic induction
E. Testing electromagnetic

ELECTRIC GENERATORS AND MOTORS

I. Generators
A. Definition
B. Principle of operation
C. Parts of generator
D. AC generators
E. DC generators
F. Uses of generators

II. Electric motors
A. Definition
B. Principle of operation
C. Parts of motor
D. Comparison of motors to generators
E. AC motors
F. DC motors
G. Universal motors
H. Uses of motors

RECTIFICATION OF ALTERNATING CURRENT TO DIRECT CURRENT

I. Rectification
   A. Definition
   B. Principles of rectification
      1. AC
         a. Uses of AC
      2. DC
         a. Uses of DC
   C. Types of rectifiers
      1. Diodes
      2. Selenium rectifiers
      3. Vacuum tubes

DIRECT ENERGY CONVERTERS

I. Magnetic converters
   A. Definition
   B. Types
      1. Characteristics
      2. Applications
II. Plasma converters
   A. Definition
   B. Types
      1. Characteristics
      2. Applications
III. Biological converters
   A. Definition
   B. Types
      1. Characteristics
      2. Applications
IV. Oceanic converters
   A. Definition
   B. Types
      1. Applications

ALTERNATING CURRENT AND POWER TRANSMISSION

I. Capacitors and capacitance
   A. Ignition capicitor
   B. Construction of capacitor
   C. Action of capacitor
   D. Testing capacitor
II. Transformers and their action
   A. Step down
   B. Step up
   C. Basic laws of transformers
III. Means of transmitting electrical power
   A. Principle involved
      1. Electromotive force

2. Application of principle

B. Conductors and insulators
   1. Electron theory
   2. Principle involved
   3. Application of principle

C. Voltage, current and resistance
   1. Ohms Law
   2. Direct current circuit
   3. AC circuit

FLUID POWER

FLUID POWER

I. Introduction to fluid power
   A. Definition
   B. Relationship of fluid power in history
   C. Exploration of the basic terms that are associated with fluid power
      1. Hydraulics
      2. Pneumatics
   D. Application of fluid power in todays usage
   E. Advantages of fluid power
II. Hydraulics and pneumatics
   A. Definition of each
   B. Common characteristic of each
III. Hydraulics
   A. Pascal's law
   B. Bernoulli's principle
IV. Identifying or exploring hydraulic components
   A. Reservoir
   B. Tubing, pipes or hose
   C. Pump
   D. Valves
   E. Motor or cylinder
V. Introduction of a typical hydraulic system
   A. Component placement
   B. Relationship of each to the system
   C. Operation of each component
VI. Explorations
   A. Pressure changes and effects
   B. Fluid flow and flow rate
   C. Use of flow control valves
   D. Action of directional control valves

PNEUMATICS

I. Pneumatics
   A. Comparison with hydraulics
   B. Disadvantage of pneumatics
   C. Boyle's law
II. Pneumatic components
   A. Pump or compressor
   B. Receiver, storage cylinder, air cylinder, or air bottle to act as a reservoir
   C. Hoses or pipes
   D. Valves
   E. Motor
III. Application of pneumatics in everyday life
   A. Tools
      1. Grinders
      2. Buffers
      3. Sanders
      4. Drills
      5. Screwdrivers

6. Nut setters
7. Wrenches

B. Air hoist
C. Rivets, Chipping, and sand hammers
D. Clamping devices
E. Blasting cleaner
F. Spraying
G. Air control circuits

V. Safety in hydraulics and pneumatics
A. Personal safety
B. Material safety
C. Equipment safety
D. Shop safety

VI. Laboratory experiences

TRANSPORTATION TECHNOLOGY

I. Transportation technology
   A. Why man transports
      1. To move from point A to point B
      2. Because of needs or wants
         a. Emotions
         b. Food
         c. Shelter or protection
         d. Comfort
         e. Recreation or pleasure
         f. To change environment
         g. Others
   B. What man transports
      1. Man
      2. Animate objects
      3. Tangibles
      4. Intangibles
      5. Other
   C. Where man transports
      1. Land
      2. Sea
      3. Air
      4. Space
      5. Other (within systems, universe, etc.)
   D. How man transports
      1. The container or vehicle
      2. The energy
      3. The propulsion
      4. The guidance
      5. The channel
      6. Other
   E. Systems of transportation
      1. Land
      2. Sea
      3. Air
      4. Space
      5. Combined

II. The development of transportation technology
   A. Limiting factors of the past--why, what to, where to and how to transport
   B. Contemporary factors--why, what to, where to, and how to transport
   C. Future opportunities, needs and wants--why, what to, where to and how to transport

TYPICAL RESOURCE UNITS (SEMESTER PROGRAM)

HYDRAULICS UNIT

Introduction to the Unit

Hydraulics is the study of fluids at rest or in motion. In the 11th century, Pascal formulated the fundamental law that modern hydraulics is based on. According to Pascal, "A force exerted on a confined liquid is transmitted equally and undiminished on all equal areas".

Hydraulics is a large and growing industry and can offer several advantages which make it an attractive power transmission system.

A. Hydraulics produces linear or rotary motion without the use of gears, chains, or belts which may require more maintenance effort.
B. Hydraulic components lubricate themselves with hydraulic oil.
C. Hydraulic power is flexible
D. Hydraulics are capable of exerting forces to fit the need, tremendous forces or very delicate forces.
E. Hydraulic power is smooth and since hydraulic oil is virtually incompressible, instant power response without jerks, is attained.

Hydraulics is used today in most of our heavy machinery and some small machinery and in industry.

This typical Resource Unit in Hydraulics is planned for 9th grade students for one semester. The class will meet for a typical 55 minute period, five days a week. The unit is designed to give students an understanding of the basic principles of and an opportunity to apply these principles by preparing different set ups using the fluid power equipment in the lab.

MATERIALS

In as much as aids are extremely important for good teaching, every effort will be made to use as many teaching aids as possible. When ever possible, students will be involved in planning and constructing aids. Some of these aids are as follows:

A. Chalk board
B. Textbooks for each student
C. Diagrams and schematics
D. Films (if applicable)

SUGGESTED TEXTBOOKS

GEORGE E. STEPHENSON
Power Technology, Litton
Educational Publishing, Inc.
1969

CHARLES S. HEDGES
Industrial Fluid Power
Womack Educational Publication
1972

LESSON OUTLINE

I. Hydraulics
   A. Definition
   B. Example of its application in todays life
   C. Common characteristics
   D. Blaise Pascal theory
II. Bernoulli's principle
   Hydraulic components
   A. Reservoir
   B. Tubing, pipes or hose
   C. Pump
   D. Valves
   E. Motor or cylinder
III. Identification and usage of hydraulic components
   Assignment
   Draw a typical hydraulic system to the best of your ability and include all of the hydraulic components, showing the flow of fluid.
IV. Exploration of Pascal Law

SUGGESTED TEACHING METHODS

The following teaching methods will be used to present the various phases of the unit.

1. Demonstrations----------Manipulated operations
2. Class discussion-------Related information & safety
3. Individual reports----Special student assignments
4. Simple hands-on laboratory experiences

TYPICAL EVALUATION

Directions

Read each question carefully and encircle the correct answer if the statement is TRUE or FALSE. Fill in the appropriate space with the correct answer if the statement is a completion type.

1. Name three ways in which fluid power has been used throughout history_____,_____, _____.

2. Hydraulics is the study of fluids at rest (static) or in motion (dynamic)
   a. True
   b. False
3. Name five basic components that make up a basic hydraulic system_____,_____,_____,

   _____,_____.

4. According to Pascal, "A force exerted on a confined liquid is transmitted equally and undiminished on all equal areas".
   a. True
   b. False
5. List three everyday applications for hydraulic systems _____,_____, and_____.

6. Valves are used to control the rate of fluid flow, the pressure of the system or the direction of the fluid flow.
   a. True
   b. False
7. List three different types of valves used in the hydraulic system_____,_____, and_____.

8. The reservoir is a steel tank that is large enough to hold a sufficient reserve supply of hydraulic oil.
   a. True
   b. False
9. List two advantages of the field of hydraulics

   _____, and _____.

10. Pascal's Law expressed mathematically is: Pressure X Area = Force.
    a. True
    b. False

GENERATOR UNIT

Introduction to the Unit

This unit was designed for ninth grade students in order that they could be exposed to generators and understand the basic principles involved in the generation of electrical power. The unit covers only the basics of generators and should be a "first-time" introduction of generators to ninth grade students.

The time involved in this unit should take approximately one 55 minute class period, 5 days a week.

BEHAVIORAL OBJECTIVES

1. The student should be able to describe the basic principles of electrical power generation.
2. The student should be able to name all the parts of an electric generator.
3. The student should be able to explain the difference between AC and DC generators.

CLASSROOM DISCUSSION

Generators are used to convert mechanical energy into electrical energy. Electrical energy produced by a generator is in the form of electrical current or movement of electrons.

In order to understand the operation of a generator it is necessary to know that when a coil of wire passes through a magnetic field, electrons will flow through the wire in the coil. This is the basic principle on wnich generators work.

A generator can produce either Alternating Current or Direct Current depending upon how the current is taken from the commutator.

An AC generator uses slip rings that slip along the commutator and allow the brushes to pick up the current that is produced continously.

A DC generator only has brushes touching the commutator that allow the transmission of direct current. This explanation of the difference between AC and DC generators has been greatly simplified in order that the basic principle could be easily understood by junior high students.

An AC generator is called an alternator. Many of the new cars produced today use alternators instead of DC generators.

Electrical power that is produced and used for homes and industry is produced by large AC generators.

TYPICAL EVALUATION

1. What is the basic principle of the generator?
2. Name all of the parts of a typical AC generator.
3. Name all of the parts of a typical DC generator.
4. Explain the main difference between an AC and a DC generator.

NATURE OF MAGNETISM UNIT

Introduction to the Unit

The early mystery of magnetism has puzzled man for many ages. There are tales of magnetism in mythology and ancient history. Mohomet's iron coffin was said to suspend in mid-air by strange magnetic forces. There were also tales of magnetic islands scattered about the seas of the world that were said to draw the nails from ships passing by. Although the location of these islands were never revealed, sailors who thought they might pass near them insisted on the use of wooden pegs in the construction of their ships.

Early man found pieces of lode stone and discovered that it would attract pieces of iron, steel and cobalt. The ancient Chinese learned that a piece of this stone suspended on a string would always point to the north and south which later led to the development of the magnetic compass.

Any object which has the property of attracting iron and steel is known as a magnet. Mineral magnetite has this property in its natural state and is called a natural magnet. The mineral has little value today because of its unstable condition. Better magnets are made artifically from iron, steel, nickel, cobalt and alloys of these and other metals, as well as certain ceramic materials.

BEHAVIORAL OBJECTIVES

Each student will:

1. Explore the areas of magnetism.
2. Investigate the mysteries of magnetism through hands-on experiments in the laboratory.

LESSON OUTLINE

I. Principles and properties of magnets and magnetic forces
   - A. Magnet
     1. Characteristics
     2. Metals used
   - B. Magnetic poles
     1. North pole
     2. South pole
     3. Space between poles
     4. Attracting poles
     5. Repelling of poles

C. Basic laws of magnetism
    1. Like poles repel, unlike attract
    2. Left hand rule
    3. The force of attraction varies between magnets directly as the product strength
D. Types of magnets
    1. Bar
    2. Horseshoe
    3. Electromagnet
    4. Destroying magnetic power of magnet
E. Use of magnets
    1. Compass
    2. Lift steel scrap
    3. Electric motors
    4. Gas engines
    5. Doorbell
    6. Starter
    7. Generator
F. Make a magnet
    1. Use stroke method
    2. Magnetize bar by striking with hammer.
    3. Induct piece of metal with electricity.

II. Principles and applications of electromagnets
A. Electromagnet
    1. Relationship of current flow
    2. Construction of electromagnet
B. Magnetic field
    1. Magnetic field about current carrying conductor
    2. Magnetic field between parallel conductors
    3. Magnetic field between parallel conductors (different direction)
C. Left hand rule
    1. Direction of current flow
    2. Resultant magnetic field
D. Electromagnetic induction
    1. Current induced from one coil to another
    2. Operation of solenoids
E. Testing electromagnet
    1. Magnetize iron bar
    2. Lift nails with electromagnet with 2 batteries
    3. Lift nails with electromagnet with 3 batteries
    4. Allow students to explore with equipment

Test

MOTIVATIONAL ACTIVITIES

Use the introduction to the unit data information written to start the unit. With a small bar magnet pull several pens and pencils (with metal clips) from students shirt pockets. Next, throw five pound 3d nails on the floor and ask four students to pick them up while another student times them. After they are all back in

the container again throw them on the floor and give a horseshoe magnet to one student and ask him to use it to pick up the nails and put them into the containers. This demonstration shows how much the magnet aids him.

Have a student scatter iron filings on paper and place a bar magnet underneath and observe the lines of force. Tape the paper to aid in alignment. Trace the "lines of force" formed by this experiment.

Have iron, nickel, cobalt and steel available for students to magnetize from a strong bar magnet. Students will take two bar magnets and suspend them from a string and put North to South, South to South, and North to North.

Student will hit a piece of pipe with a hammer and magnetize it and then use it to pick up nails. He will turn it over and hit it again changing poles and pick up the nails again.

Student will abuse magnet and observe how it loses its magnetism.

Students will use their magnets to find their way across a dark room (from north to south) using only a pen lite to shine on their compasses.

Students will construct electromagnet and magnetize soft iron core in the laboratory.

Have solenoid and door bell hooked up and let students demonstrate principles of each to each other.

Take an electric starter and generator apart. Have students use parts to generate current (through a VOM) to demonstrate how a magnet produces electricity.

TYPICAL EVALUATION ON UNIT

1. Name two types of magnets?
2. Can the center area of a bar magnet attract iron?
3. Can magnetism be destroyed by physical abuse?
4. What is the basic law of magnetism?
5. What is the Left Hand Rule?
6. In the experiments with magnets, do likes attract?
7. In an electromagnet - as the current increases does the attractive force of the magnet decrease?
8. Draw the field around a bar magnet.
9. Draw a field around a horseshoe magnet.
10. What function does a magnet have in an ignition system?

MATERIALS FOR UNIT

1. Bar magnet
2. Horseshoe magnet
3. Iron fillings
4. Two bars soft core iron
5. Twenty pound enamel copper wire, 100 feet
6. 2 - 1 1/2 volt DC batteries (screw tops)
7. 2 coils copper wire, 20 lb. 4 feet
8. 1 volt meter
9. Laminated iron core
10. 2 coils copper wire, 10 lb. - 24"
11. 10 sheets tracing paper
12. 1 piece cardboard, 12" by 18"
13. 1 piece copper wire, 10 lb. - 24"
14. Doorbell
15. Compass, needle type
16. 5 lb. 3 D nails
17. Electric fan motor
18. Lawnmower gas engine
19. Starter from car
20. Generator from car
21. Hammer
22. Iron pipe 12" long, 1 inch in diameter
23. One solenoid

Training film: 16 mm "Magnetism and You"
Orange B. Film Bank

CURRENT CARRYING ABILITY OF MATERIALS

Introduction to the Unit

Working with electricity necessitates using a variety of materials which have the ability of either carrying much current, carrying extremely little current, or of carrying some current. These various materials are named respectively: conductors, insulators, and resistors.

BEHAVIORAL OBJECTIVES

1. Students will be able to explain the difference between conductors, insulators, and resistors.
2. Students will be able to identify four common materials as being conductors and four common materials as being insulators.
3. Students will be able to explain the effect that size and length have on the current-carrying ability of a conductor.

MOTIVATION TECHNIQUES

Have a student walk to a light switch and flip the lights off and then back on. Have him return to his seat and ask him why he wasn't electrocuted while he was controlling electricity a moment before. Promote a discussion of the need for insulating materials to keep electricity where we want it. Ask a student to name some materials that are insulators. Ask a student how electricity can be carried from one place to another. Promote a discussion of conductors as carriers of electricity. Ask a student to name some materials that will conduct. Challenge the class by asking how they are sure that what they named as insulators or as conductors, really are such. Ask them if they themselves are conductors or insulators. Tell them that they can find out during the day's activity which will involve determining the relative resistance of various materials.

LABORATORY ACTIVITIES

Perform the following laboratory experiences and record your findings in the chart below.

LAB DATA SHEET

Type of Material	Size and Length Description	Resistance	Identification

EXPERIMENTS

1. Measure and record the resistance of the four given metals and the four given non-metals, and identify each as a conductor or as an insulator.
2. Measure and record the resistance of a five foot piece of fine gauge copper wire. Do the same for a ten foot piece. Explain why there was a difference in the answers even though both were copper wire. What would you expect the resistance to be if the wire were twenty feet long? One hundred feet long?

3. Record the resistance of a ten foot piece of heavy gauge copper wire. Compare this answer with the ten foot piece of fine gauge copper wire. Why weren't the answers the same if both wires were copper?
4. Would you also expect that size and length would affect the resistance of a steel wire? Of an aluminum wire?
5. What conclusions can you draw concerning resistance and wire size? Resistance and length?
6. From your data, what material seems to be the best conductor?
7. Secure a piece of nichrome wire from the instructor. Measure and record its resistance. Notice how much resistance it has for its size and length compared to the other metal samples. It is neither a conductor nor an insulator. It is called a resistor.
8. Measure and record your body resistance from hand to hand. Are you a conductor, an insulator, or a resistor?

MATERIALS FOR THE UNIT

1. Ohmmeters (VOM)
2. Steel wire or rod
3. Brass wire or rod
4. Aluminum wire
5. Fine gauge copper wire
6. Heavy gauge copper wire
7. Nichrome wire
8. Wood sample
9. Glass sample
10. Leather sample
11. Plastic sample
12. Yardstick

TYPICAL EVALUATION

Circle the correct answer to each of the following statements:

1. A wire that is 25 feet long has a resistance of one ohm. If it were 50 feet long it would have a resistance of 1/2 ohm.
   a) True
   b) False
2. Aluminum is an insulator.
   a) True
   b) False

3. The larger the size of a wire, the less resistance it has.
   a) True
   b) False
4. Plastic is a good conductor.
   a) True
   b) False
5. Copper has the same resistance no matter what its size.
   a) True
   b) False
6. The longer a wire is, the greater its resistance.
   a) True
   b) False
7. Copper is a better conductor than steel.
   a) True
   b) False
8. Nichrome wire can be used to make a resistor.
   a) True
   b) False
9. Leather is a conductor.
   a) True
   b) False
10. Glass is an excellent insulator.
   a) True
   b) False

ROCKET ENGINE UNIT

Introduction to the Unit

During this unit, the student will be exposed to the various stages of development and application to use of rocket engines from the German V-1 rocket to the development and actual application of the Saturn rocket. Having presented a knowledgeable background to the student in such areas as safety, basic rocket design, propellants, motor systems, instrumentation, testing and launch site layout and construction, it would be possible for student to construct such hardware in model form thus stimulating further interest in development and application.

Suggested time frame for teaching this unit is fifteen, fifty-five minute class periods.

BEHAVIORAL OBJECTIVES

The student will:

1. Be able to explain the historical development of rockets.

2. Be able to apply their knowledge of rocketry to model building and test flying.

LESSON OUTLINE

1. Safety
   a) Why such stress on safety
   b) Injury from handling of propellants with contact with skin
   c) Injury from handling of propellants (explosion)
   d) Injury from high noise levels
2. Basic rocket design
3. Basic principles of propulsion
   Aerodynamic balance
   a) How to design and build a simple rocket
   b) Rocket
4. Types of propellants
   a) Solid propellants
   b) Liquid propellants
   c) Trends in propellant development
   d) Safe propellants for amateur use
5. Rocket motor systems
   a) Solid propellant motors
   b) Liquid propellant motors
   c) Rocket motors design for amateurs
6. Rocket instrumentation
   a) Telemetering
   b) Types and use of instrumentation
   c) Types of igniters
      (1) Mercury switch
      (2) Inertia switch
7. Preflight testing
   a) Why test?
   b) Testing devices
   c) Preflight trajectory analysis
8. Launch sites
   a) Design
   b) Topographic considerations
   c) Communications
9. Range and landing sites
10. Tracking and evaluation of data

MOTIVATION TECHNIQUES

The instructor should make a thought-provoking presentation of rocket facts such as the following:

> The initial test flight of the first stage of the Saturn booster reached an altitude of only 85 miles and a peak speed of 3590 miles per hour but this occured as far back as October 27, 1961. The booster then came down in less than eight minutes and only 215 miles away. However, even

then, the engines delivered 1,300,000 horsepower at lift-off which translated to the full potential of more than the total of 100,000 autos of that year. Further, this power was delivered in less than four seconds of burning time. The 162 foot high rocket weighed 460 tons at lift-off of which 300 tons was kerosene, liquid oxygen, fuel and oxidizer.

It is felt that such an introduction would serve to initiate dialogue and class discussions. Having presented such facts, the instructor should be able to promote further discussions to achieve the stated behavioral objectives.

As a hands-on experience, the instructor should encourage students to design (for display in the classroom) a model rocket and a rocket engine for a specific purpose and be prepared to defend their design in terms of its intended application.

SUGGESTED MATERIALS FOR THE UNIT

Books:

Rocket Manual for Amateurs, by Captain Bertrand R. Brinley, Ballantine Books, New York (1960)
Note:
This single book will provide the instructor with charts, graphs and drawings required to effectively teach this unit.
Space Guide, by Vincent F. Callahan, Callahan Publications, Washington, D.C.

Transparencies for overhead projection:

T-14-1 Simple Turbojet Engine
T-14-2 Modern Turbojet Engine
T-15-1 Solid Fuel Rocket
T-15-2 Liquid Fuel Rocket
T-16-1 Types of Gas Turbing Engines
T-16-3 Diagram of Gas Turbine Engine
T-16-5 Basic Components of Gas Turbine Engines
Note:
Above transparencies obtainable from:
DCA Educational Products
4865 Stenton Ave.
Philadelphia, Pa. 10144 Total cost $22.90

SUGGESTED EVALUATION DEVICE

Determine whether each of the following statements is true or false. If the statement is true, circle the "T" preceding the statement; if the statement is false, circle the "F".

T F 1. Safety is very important around rockets because even mere handling of some propellant can cause it to explode.

T F 2. The principle of rocket propulsion is based on one of Newtons Laws of Motion which states that for every action there is an equal and opposite reaction.

T F 3. In its simplest form, a combustion chamber constitutes a complete rocket motor.

T F 4. Propellants may be either in solid or liquid form.

T F 5. A rocket motor always works better and more efficiently in space than where there is air.

T F 6. When we talk about instrumentation, we mean everything that is used to measure and record or transmit back to earth, information from or about the rocket.

T F 7. When we talk about weightlessness and "zero gravity", we are talking about two different things.

T F 8. One of the greatest advantages of solid propellants over liquid propellants is that they are easier to handle.

T F 9. Satellites orbiting in space today permit us to have telephone circuits around the world. Television pictures also, are transmitted in much the same way around the world.

OIL & LUBRICANTS UNIT

Introduction to the Unit

It has become of increasing concern to educate our youth to an understanding that advertising of consumer products doesn't always present the total truth - in most cases, just a fragment presented out of context.

Students in ninth-grade Industrial Arts studying Power Technology are at an age at which transportation, either by two or four wheels, is of utmost importance.

This series of four laboratory experiences in the study of oils as a lubricant is designed to meet the following objectives:

1. To develop an awareness that the lubricant oil is only one of many products derived from petroleum.
2. To develop the ability of students to compare different types and brands of oil, and then make an intelligent selection of an oil for a specific application.
3. To develop an awareness that engines operating under varying conditions affect the lubricant required in different ways.

One of these laboratory activities is attached as a part of this unit.

LESSON OUTLINE

I. Petroleum fuels
   - A. Methods of rating fuels
     - 1. Laboratory test
     - 2. Road test
       - a. Cooperative fuel research test
       - b. Modified borderline test
   - B. Types and characteristics of gasoline
     - 1. Types
       - a. Iso-octane
       - b. Heptane
       - c. Mixtures of iso-octane and heptane
     - 2. Characteristics
       - a. Hydro-carbon compounds
         - (1) Octane rating (ONR)
         - (2) Tetra-ethyl lead
       - b. Volatility of gasoline
       - c. Additives

II. Lubricating oils

A. Questions asked about oils
B. Words to be defined
C. Development of engine lubricants
    1. Processing of crude oil
    2. Products derived from petroleum
D. Purpose of lubricants
    1. Definition
    2. Types of friction
        a. Sliding
        b. Fluid
E. Development of quality standards
    1. S.A.E. viscosity rating
    2. A.P.I. service grades
F. Making of a new oil
    1. Selection of additives by manufacturer
    2. Supplementary additives
G. Affect of oil viscosity on starting

III. Greases
A. Functions of lubricating grease
B. Types and characteristics of greases
C. Applications
    1. Automotive
        a. Drive lines
        b. Suspensions
        c. Steering
    2. Cycle
    3. Heavy equipment
    4. Marine
    5. Aviation

A TYPICAL LABORATORY EXPERIENCE

Activity I

Products Derived from Petroleum

OBJECTIVES

1. The student will be able to explain the purpose of lubricants.
2. The student will be able to describe how petroleum is processed.

REFERENCE

1. Review pages_____in text.
2. Review handout
3. Review pamphlet "Lubrication," from GM
4. Film - - "Refinery at Work," 16 mm from Humble Oil Co.
5. Overhead transparencies

STUDENT ASSIGNMENT

You are to generate as much friction between the two steel blocks as possible by sliding them back and forth. Then place a thin film of oil between the two blocks and repeat. Did you notice any difference?

Clean both blocks in the parts washer. Dry and return the blocks to your work station. Complete the general study questions.

GENERAL STUDY QUESTIONS

1. How many petroleum products other than gasoline are used by your family?

a. d.
b. e.
c. f.

2. How is sliding friction between two metal surfaces changed to fluid friction?

HOMEWORK

Bring in an empty quart oil can to class tomorrow, any type or brand. These may be obtained from most any service station.

MATERIALS AND EQUIPMENT FOR THE UNIT

1. Pamphlet, "Lubrication," from General Motors.
2. Slides, "Start, Stop and Store," from Spencer Engine & Magneto, Inc.
3. Film "Refinery at Work," from Humble Oil Company.
4. Film, "The Daytona 500," from Goodyear.
5. Transparencies, see attached list.
6. 16 mm projector
7. Carousel projector
8. Chalkboard
9. Bulletin board
10. Viscosimeter
11. Engines, automobile/motorcycle/outboard.
12. Cut-a-way engines, 4-cycle/2-cycle
13. Two quarts oil, SAE 10W-30.
14. One can, STP.
15. One large screwdriver per group.
16. One gallon mineral spirits.
17. Two steel blocks, any convenient size, per group.
18. Ice storage chest.
19. Bag of cleaning rags.
20. Bunsen burner per group.

PRE AND POST-STUDY EVALUATION

1. Contaminants found in oil taken from a "cold" engine probably would include: (Choose one)

   a. water
   b. varnish
   c. soot
   d. water and varnish
   e. water and soot

2. Which of the following is a petroleum product? (Choose one)

   a. gasoline
   b. asphalt
   c. vasoline
   d. fuel oil
   e. all of the above

3. Which product requires friction to be functional? (Choose one)

   a. all of the following
   b. bowling ball
   c. shoes
   d. tires
   e. pencil

4. A low-viscosity oil offers: (Choose one)

   a. low oil consumption
   b. good lubrication above 65 mph
   c. instant lubrication
   d. suitability for all-year use

5. Which does not belong with a "MS" service grade? (Choose one)

   a. heavy loads
   b. occasional high speeds
   c. stop-and-go driving
   d. dusty conditions

6. The oil SAE 10W-30: (Choose one)

   a. flows as freely as a 10W oil at 0-degrees F.
   b. is suitable for all-year use in most areas
   c. retains the body of SAE 30 oil at 210 degrees F.
   d. all of the above

7. If an additive improves the viscosity of an oil, it has: (Choose one)

   a. thinned the oil
   b. thickened the oil
   c. cleaned the oil
   d. all of the above

8. Which does not describe a property of oil? (Choose one)

   a. elasticity
   b. adhesion
   c. viscosity
   d. cohesion
   e. all of the above

9. How often should the oil be changed in an automobile? (Choose one)

   a. 2000 miles
   b. 4000 miles
   c. depends upon the driving conditions
   d. depends upon the manufacturer's recommendations

10. Before you purchase any type of oil, you should consider: (at least three things)

   a.
   b.
   c.

UNIT ON HYDRAULICS AND PNEUMATICS

THE FLUID TRANSMISSION OF POWER

Introduction to the Unit

Man has for centuries been using the forces of nature to help him do his work - from the sailboat and water wheel to today's sophisticated turbines and automobile accessories - some of the same basic concepts are used. The harnessing of natural forces for man's use can be an interesting and challenging subject.

The use of a fluid - either liquid or gas - to a mechanical advantage is fluid power. Consider the water wheel and the sail boat; then consider power steering and windshield wipers. This unit shall tie together these and other applications of the fluid transmission of power.

Approximately two weeks, of 55 minute periods should be sufficient for this unit.

BEHAVIORAL OBJECTIVES

1. Students should understand the basic theoretical concepts of the power of fluids. This includes the laws and principles of Pascal, Bernoulli, Boyle, and Charles.

2. Students should be able to apply these theories to the practicalities of engines and their accessories.

3. Students should have hands-on laboratory experiences to demonstrate the reality of the theories.

LESSON OUTLINE

I. Physical laws and principles of hydraulics (lab experience with jack)
   - A. Pascal's law of static liquids
   - B. Bernoulli's principle of dynamic behavior of liquids
   - C. Other concepts: incompressibility, friction, turbulence

II. Basic circuits and identification of components (lab with basic system)
   A. Reservoir, pipes, pump, valves, and cylinder
   B. Valves in detail: types, function and operation
   C. Pumps in detail: types, design, and operation
   D. Conductors, pipes, in detail: types and functions
III. Applications of hydraulics and hydraulic accessories and their functions (lab with pencil sharpener)
   A. Power steering
   B. Air conditioning
   C. Fuel pump
   D. Brakes
   E. Jacks and other machinery
IV. Physical laws and principles of pneumatics
   A. Pascal's law of static pressure
   B. Boyle's law of pressure
   C. Charles' law of pressure and temperature
   D. Other concepts: compressibility
V. Pumps and compressor design and operation (lab with bicycle pump)
   A. basic eylinder
   B. turbines
VI. Practical applications of pneumatics and pneumatic accessories (lab with paint sprayer)
   A. tools
   B. paint sprayer
   C. back-up systems

MOTIVATION

The students shall have several hands-on experiences to involve themselves more thoroughly with the basic concepts.

RECOMMENDED MATERIALS

Texts suggested are as follows:

Air Tools. Willowick, Ohio: Stanley Air Tools, 1966.

Altland, George, Practical Hydraulics. Troy, Michigan: Vickers, Inc.

Fundamentals of Compressed Air Power, The. Cleveland, Ohio: Compressed Air and Gas Institute, 1966.

Stephenson, George E. Power Technology. Albany, N.Y.: Delmar Publishers, 1969.

Walker, John R. Machining Fundamentals. Homewood, Ill.: Goodhert-Wilcox, 1969.

Other material suggested:

Bulletin boards for visual reinforcement:

1. Illustrating the basic hydraulic and pneumatic theories
2. Diagram of bicycle pump

Realia for laboratory experience: pumps, paint sprayer, hydraulic jacks, pencil sharpener and small hydraulic system

TYPICAL EVALUATION DEVICE

1. Fluid power can be exerted by the use of either of two types of matter, _____ or _____.
2. Liquids (can, cannot) be compressed. Gases (can, cannot) be compressed. Nevertheless, both can transmit power.
3. Friction is a problem in mechanical transmission of power. Is it also a problem in the fluid transmission?
4. Name at least three practical uses of the hydraulic transmission of power.
5. Name the four types of hydraulic valves and describe the functioning of two of these.
6. Discuss one of the basic laws of hydraulics; e.g., Pascal's, Bernoulli's.
7. Describe why the bicycle pump can inflate a balloon better than you can by blowing into it.
8. Though both transmit power in much the same way, how are gases different from liquids?
9. Discuss one of the basic laws about pneumatics; e.g., Pascal's, Boyle's, Charles'.
10. Write three more things you have learned in this unit.

TRANSMISSION OF POWER (BELT DRIVES) UNIT

Introduction to the Unit

This Resource Unit is intended to serve as a guide in presenting to the 9th grade junior high student the various mechanical transmissions of power through belt drives. This is an essential unit which can be easily taught with a few inexpensive teaching aids. Various belts and pulleys can be obtained at very low cost or in some instances as discarded items. Lab activities and experiments can be developed easily. This unit would best be taught before or right after the unit on chain drives. These units would serve as

introductory units for a main unit of Mechanical Transmission of Power. Approximately two class periods would be allowed for this unit.

BEHAVIORAL OBJECTIVES

1. After having received instructions and class demonstrations covering this unit of Types and Characteristics of Belt Drives, 90% of the students will make a score of at least 70 on the teacher-made test.

2. Students will participate in class discussion and laboratory activities.

3. Students will be able to adjust a belt drive properly.

LESSON OUTLINE

I. Types and applications of gears and gear drives
   A. Types of gears and gear drives
      1. Four main types of gears
         a. spur
         b. helical and spiral
         c. worm
         d. bevel
      2. Combinations and variations of the four types
         a. spur-pinion and internal gear
         b. spur-pinion and rack
         c. single and double-helical gears
         d. helical pinion and rack
         e. crossed helical gears
         f. straight bevel gears
         g. straight bevel gear and crownswheel
         h. spiral bevel gears
         i. hypoid gears
         j. side-bevel
         k. ring
         l. planetary
         m. center or sun
         n. herringbone
         o. noncircular (logarithmic spiral) (eliptical for cycle speed variations)
   B. Characteristics of gears
      1. Gear ratio
      2. Dimensions of gears
         a. depth of tooth
         b. center distance
         c. clearance
         d. tip relief
         e. blank diameter
         f. number of teeth

g. lead
h. height
i. backlash

C. Defects in gears in service
1. Noise
2. Complete failure
3. Tooth breakage
4. Pitting
5. Uneven contact
6. Scuffing
7. Wear
8. Rolling and spalling
9. Fusion
10. Scoring
11. General causes (those failures that defy precise classification)

D. Applications of gears and gear drives
1. Automotive, truck, buses, agriculture equipment, boats
a. steering
b. cam and distributor
c. starter and flywheel
d. transmission
e. differential
f. instruments
g. power and mechanical window
2. Industrial machines
a. drill press
b. lathe
c. milling machine
d. hand operated drill
e. power drill
f. sheet metal machines
3. Marine reduction gearing
4. Aircraft (prop adjustment)
5. Clocks
6. Small appliances
7. Sewing machine

II. Types and characteristics of clutches
A. Automotive types of clutches
1. Semicentrifugal
2. Diaphragm-spring and crown pressure-spring

B. Construction of the automotive clutch
1. Driving members
a. flywheel
b. pressure plate assemble
2. Driven members
a. disk with a splined hub
b. cushioning device and torsion dampening springs
3. Operating members
a. clutch bearings
b. release mechanism

C. Combination bearing clutch
1. Transmits torque; carries load

D. Roller-type clutch

E. Overrunning clutch
    1. Application
        a. two-speed drive in gear train (industrial)
        b. two-speed drive for grinding wheel
        c. freewheeling fans (auto)
        d. indexing table on machinery
        e. punch press feed
        f. intermittent motion (candy machine)
        g. indexing and backstopping (capsuling machine)
        h. double-impulse drive
        i. anti-backlash device
F. Over-riding clutch
    1. Characteristic
        a. ratchet and pawl mechanism - used to convert reciprocating or oscillating movement to intermittent rotary motion.
G. Sprag-type clutches
    1. Characteristics
        a. transmits torque in one direction and reduces speed, rest holds, or free wheels in the reverse direction.
    2. Applications
        a. overrunning
        b. backstopping
        c. indexing
H. Basic types of mechanical clutches
    1. Jaw
    2. Sliding key
    3. planetary transmission
    4. Pawl and ratchet
    5. Plate
    6. Cone
    7. Expanding shoe
    8. Spring and ball radial detent
    9. Cam and roller
    10. Wrapped spring
    11. Expanding shoe centrifugal
    12. Mercury gland

III. Characteristics of chain drives
A. Characteristics
    1. For transmitting light loads at intervals rather than continuously
    2. Not usually considered precision parts like gears
    3. No slippage
    4. No frictional losses
    5. Two-dimensional chain (time belt construction on one side and a V-Belt construction on the other)
    6. Bead chains (for light service)
B. Applications

1. Transmit power
    a. toys
    b. household appliances
    c. automobile components
    d. go karts and mini bikes
    e. instrument drive (timing)
        (1) carson dice electronic micrometer
    f. transmission (motor cycle)
    g. bicycle, tricycle
2. Industrial
    a. low-cost rack-and-pinion
    b. control-cable direction-changer
    c. lifting device
    d. extending and feeding devices
        (1) setup that feeds plywood into a brush-making machine

IV. Types and characteristics of belt drives
  A. Types
    1. V-Belt
    2. ribbed belt
    3. round
    4. flat
  B. Characteristics
    1. high efficiency and are relatively low in price
    2. V-Belt--most commonly used
    3. belts are reinforced by steel wires
    4. up to three inches wide
    5. works on the principle of friction
    6. can ordinarily be used only where an exact maintenance of velocity ratio is not essential
  C. Applications (transmit power)
    1. compressors
    2. agriculture machinery
    3. power steering
    4. operate water pump
    5. vacuum cleaners
    6. alterator or generator
    7. air conditioner
    8. lawn mower and edger
    9. grinder
    10. mini bike and go kart
    11. drill press
    12. buffers
    13. lathes
    14. milling machines
    15. blower-super charger
    16. sanders

V. Function and application of universal joints and escapements
  A. Function of universal joints
    1. To transmit power between shafts that have small angular and/or parallel mis-alignment.

B. Application of universal joints
    1. Automotive, etc. (drive train)
    2. Socket set
C. Types of universal joints
    1. Automotive type
    2. Telescoping
    3. Hooke's joint
    4. Pinned sphere
    5. Grooved sphere
    6. Constant velocity
D. Escapements
    1. Function
        a. To turn off a machine or reverse direction at a pre-determined time.
    2. Application
        a. Industrial drill press - drill heads are indexed. Electric controls activate a hydraulic cylinder which in turn releases the escapement mechanism

VI. Applications of mechanical transmissions
    1. Automotive
    2. Locomotive
    3. Truck
    4. Agriculture
    5. Aircraft
    6. Marine
    7. Industrial machine
    8. Motor cycle
    9. Earth movers
    10. Fork lift

SUGGESTED UNIT MATERIALS

Chalkboard, overhead projector, opaque projector
Slides - pictures of gears or still pictures
Bulletin board displays of literature secured from various manufacturers.
Working models or Realia - lathe, drill, press, lawn mower, edger
Charts and graphs - from manufacturers' of belt drives.
Diagrams and schematics from industry, brochures.

UNIT EVALUATION DEVICE

1. What material is used to strengthen belts?
2. What is the advantage of a ribbed belt over a V-Belt?
3. Is a V-Belt efficient?
4. What physical principle is involved that makes the V-Belt work?
5. Of the different types of belts used, which is the one most commonly used?

6. How wide are drive belts usually made?
7. Do drive belts as a whole usually maintain constant velocity?
8. Are drive belts adjustable?
9. What is the function of a drive belt?
10. List four applications of drive belts.

AIR VANE GOVERNOR ACTION UNIT

Introduction to the Unit

Most small engines in use around the home have some type of engine speed control device. The most common is the air vane(pnuematic) control. Everybody that owns or operates small engine equipment should understand the operation of the governor. The wise owner will also know how to maintain it. The air vane is simple in construction and easy to maintain.

Students working in pairs, should remove the necessary shrouding on a small gasoline engine to expose the governor. Static examination of the governor parts and assembly will be made using the manufacturers handbook before disassembly is begun. Each work team will record disassembly procedures in the work procedure form. Assembly procedures begin only after teacher inspection of the disassembled unit and the work form. When the governor is assembled, the teacher must check and ok the unit before cranking of the engine is allowed.

With the engine running, the students will observe governor operation and record observations. By adjusting spring tension and loading the engine, the students can vary engine speed and governor action. A torque meter and RPM tachometer will be used in the experiment.

Approximately five class periods should be allowed for this activity.

Objectives:

Students will be able to:

1. Understand and explain pnuematic governor action.
2. Operate small engines within safe speed ranges.
3. Perform necessary maintenance on air vane governors.

MOTIVATION: HANDS-ON LABORATORY ACTIVITY

The air vane governor will be used in this laboratory activity because of it's common use around the home. All engines used in this activity will be safely mounted on test stands.

Student lab procedure is as follows:

1. Remove only the shroud covering the flywheel.
2. In static position, operate throttle linkage noting throttle valve operation in open, closed position. Determine engine RPM from position of the throttle valve and record in work sheet.
3. Start engine and increase throttle to governed speed, check throttle position and RPM at this setting. Record findings in work chart.
4. Stop engine and decrease governor spring tension, crank engine and record throttle position and RPM, record observations.
5. Stop engine and increase spring tension. Repeat step four.
6. Compare your findings with other groups that explored identical engines.
7. Repeat step six, only compare with different make engines.
8. As a class, compare all observations recorded and draw conclusions as to effectiveness of the air vane governor on engines in various stages of wear and deterioration. Complete the attached report and hand in to your teacher.

LABORATORY ACTIVITY REPORT

COURSE_____ PERIOD_____

UNIT_____ GROUP_____

DATE STARTED_____ DATE COMPLETED_____ GRADE_____

STUDENT	OPERATIONS PERFORMED	DEFECTS NOTED	MAINTENANCE PERFORMED	TOOLS USED

EVALUATION

Each student will be evaluated on the following basis; 80% for laboratory activities, 20% for the written examination.

1. An air vane governor would be classified as a pnuematic device.
   a. True
   b. False

2. Bracket the items listed that affect governor operation.
   a. RPM of the engine.
   b. Mechanical condition of the engine.
   c. Amount of governor spring tension.
   d. Load on the engine.
   e. Amount of air flow generated by the flywheel striking the air vane.

3. Double bracket event in question 3 that directly controls the governor action.

4. The governor spring is installed to resist the governing action of the air vane.
   a. True
   b. False

5. When the governor spring tension was decreased engine speed decreased, increased, or remained the same._____

6. Knowing the maximum rated RPM of the engine, what effect did decreasing spring tension have on the engine?

7. List 2 reasons why pnuematic governors are widely used.

   1. _____

   2. _____

8. List 2 disadvantages of the pnuematic governor.

   1. _____

   2. _____

9. Using identical engines, the operational data showed some deviation, why was this so?

_____

_____

_____

10. Briefly describe the conclusions you reached as a result of laboratory activity.

UNIT ON WATER POWER

Introduction to the Unit

This resource unit is intended to enable the student to see and to understand how water power applications have progressed throughout the years. This unit will include lectures, discussions, and actual research and testing. In the research and testing unit the students will discover how water power progressed in a logical order. Approximately three class periods should be allocated to this unit.

BEHAVIORAL OBJECTIVES

1. The students will be able to list the applications of water power.
2. The students will be able to explain the advantages and disadvantages of water power in reference to river flow and ocean flow.
3. The students will be able to construct a simple waterwheel.
4. The students will know the advantages of a dam.
5. The students will be able to explain how tidal power works.
6. The students will be able to explain some of the possible future applications, especially of the water power where they live.

LESSON OUTLINE

I. Waterwheels
   - A. Early application
     1. Mill grain
     2. Run machines in factories
   - B. Modern application
     1. Hydroelectric
        - a. Disadvantages
          - (1) Not suitable for all rivers
          - (2) Ecological problems
        - b. Advantages
          - (1) Low cost power
          - (2) Control rivers
        - c. Dams

2. Ocean flow
    a. Tidal power (refer to attached article)
    b. Advantages
        (1) Taps an unused resource
        (2) Makes tide differences smaller
    c. Disadvantages
        (1) Costs
        (2) Not very effective
        (3) Ecologic
3. Future applications
    a. Nationwide
    b. Locally

MOTIVATIONAL ACTIVITY

Students will build and work with model dams. Divide the class into five groups. Have each group build two waterwheels with one wheel set up in the open stream and one in back of the dam. Then have your students answer the following questions:

1. Which waterwheel has the greatest flow? (turns per minute)

2. Cut off the flow of water to both rivers. Which wheel stops first?

3. How much longer does it take the other wheel to stop?

4. Restart the flow. Stop the flow to the irrigation pipes. What happens?

5. Which is the most useful system?

6. What is the advantage of the dam as compared to the free flow river?

7. What are some of the limitations of the dam system?

SUGGESTED QUESTIONS FOR ORAL EVALUATION

1. Name two early applications of water power.

2. What is the major advantage of using a dam?

3. Name one of the two places that have tidal power systems.

4. What is needed for a productive tidal system?

5. How did man first use water power?

6. Name two disadvantages of using a tidal power system.

7. Name two advantages of a river flow power system.

8. Name an early application of a waterwheel.

9. Which of the waterwheels flowed the longest, the free flow or the dammed one?

10. Name two future applications of water power.

MATERIAL FOR FIVE CLASSES

5 preconstructed dam models (see attached sheet) with 5 pails and 10 catch pans

75 plastic straws (3 to each dam model)

50 large corks

25 coat hangers

5 pairs of scissors

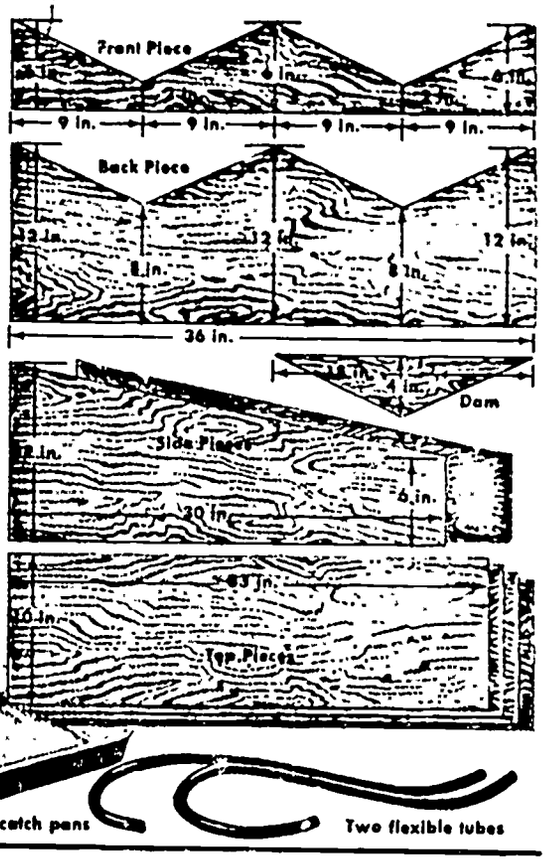
5 pairs of tin snips

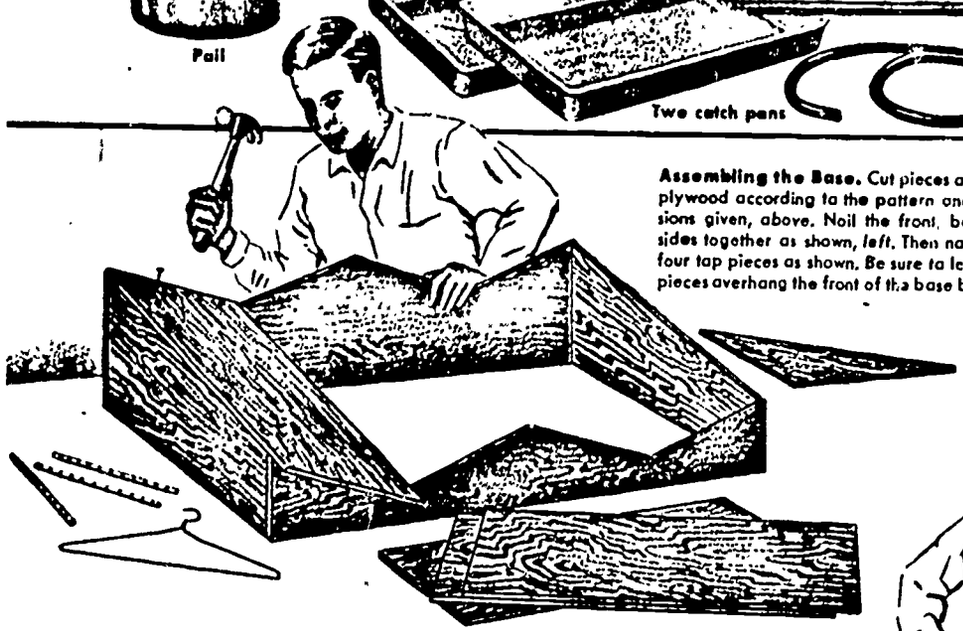
1 electric drill

A WORLD BOOK SCIENCE PROJECT

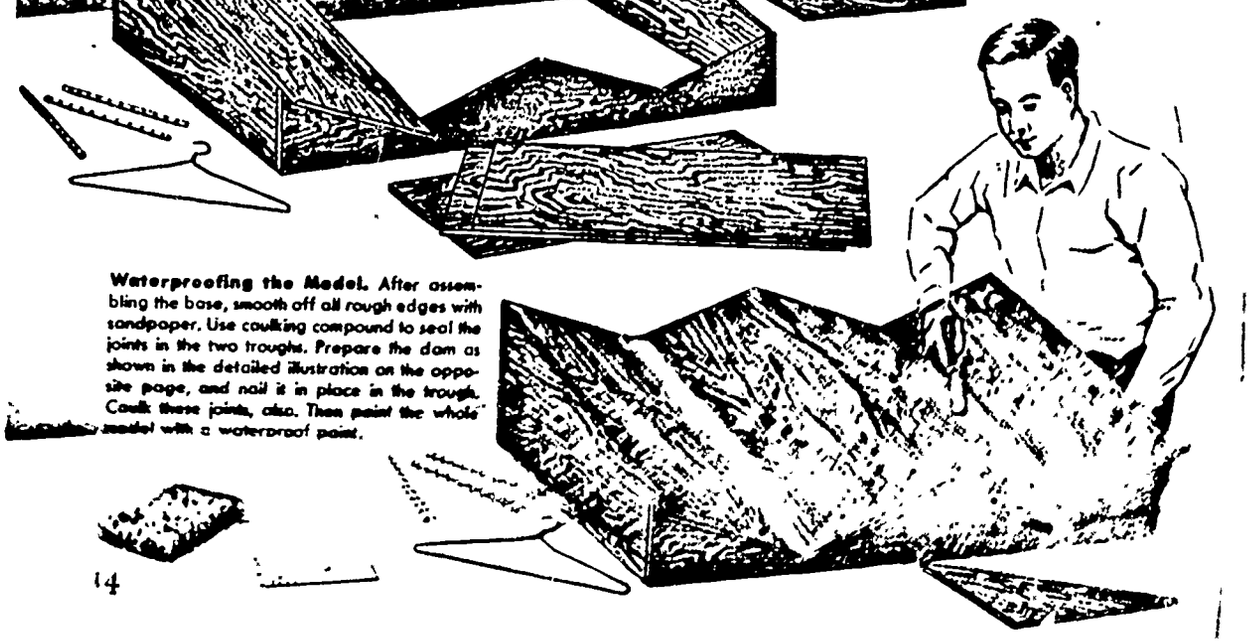
BUILDING A MODEL DAM

The purpose of this project is to show how a dam can turn a nearly useless river into a valuable asset. One part of the model represents a shallow, almost useless, stream. The other part shows how a dam can make the stream a source of power, irrigation, and recreation.





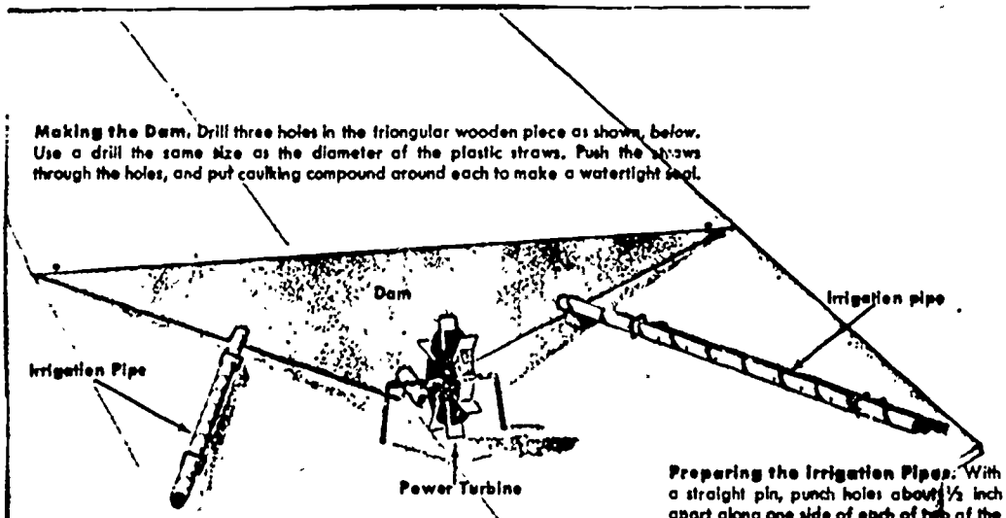
Assembling the Base. Cut pieces of ¼-inch plywood according to the pattern and dimensions given, above. Nail the front, back, and sides together as shown, *left*. Then nail on the four top pieces as shown. Be sure to let the top pieces overhang the front of the base by 1 inch.



Waterproofing the Model. After assembling the base, smooth off all rough edges with sandpaper. Use caulking compound to seal the joints in the two troughs. Prepare the dam as shown in the detailed illustration on the opposite page, and nail it in place in the trough. Caulk these joints, also. Then paint the whole model with a waterproof paint.

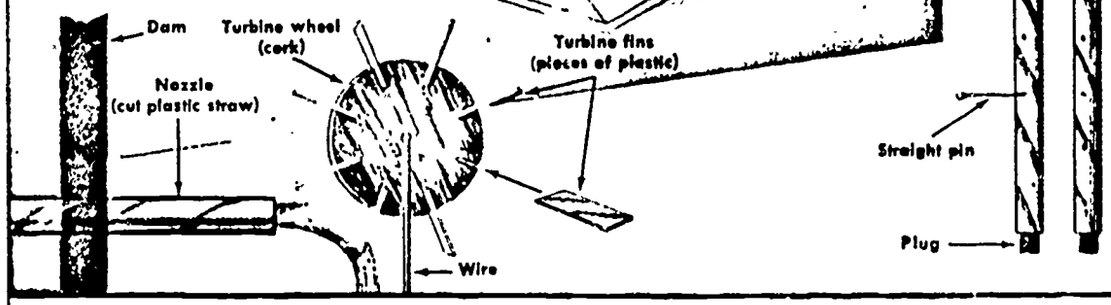
"Building A Dam," The World Book Encyclopedia, 1972, V, 4-5.

Making the Dam. Drill three holes in the triangular wooden piece as shown, *below*. Use a drill the same size as the diameter of the plastic straws. Push the straws through the holes, and put caulking compound around each to make a watertight seal.



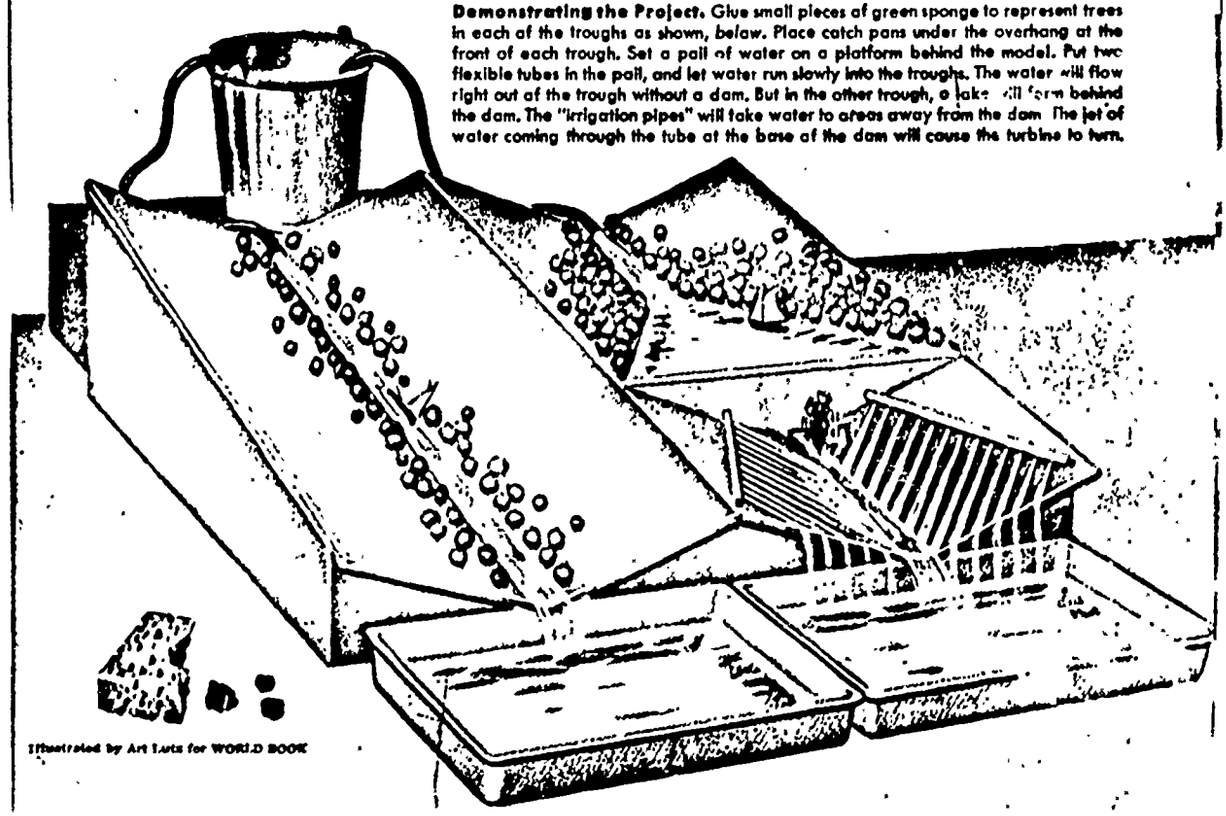
Building the Turbine. Drill a hole through the center of a large cork as shown, *below*. Make notches around the cork and insert the turbine fins, which may be pieces of tin, or thin, stiff plastic. Cut a piece of wire from a coat hanger and push the wire through the hole. Bend the wire and fasten it to the base near the dam. Be sure the cork can turn freely on the wire.

Preparing the Irrigation Pipes. With a straight pin, punch holes about ½ inch apart along one side of each of two of the plastic straws, *right*. Plug one end of each straw with clay. Push the other end through the dam as shown, *above*.



HOW THE MODEL WORKS

Demonstrating the Project. Give small pieces of green sponge to represent trees in each of the troughs as shown, *below*. Place catch pans under the overhang at the front of each trough. Set a pail of water on a platform behind the model. Put two flexible tubes in the pail, and let water run slowly into the troughs. The water will flow right out of the trough without a dam. But in the other trough, a lake will form behind the dam. The "irrigation pipes" will take water to areas away from the dam. The jet of water coming through the tube at the base of the dam will cause the turbine to turn.



Illustrated by Art Lutz for WORLD BOOK

SECTION C

Typical Course Outline

(Year-Long Program)

Mechanical, Electrical &

Fluid Power

MECHANICAL POWER

HISTORY OF POWER DEVELOPMENT

The development of power began in primitive times utilizing natural resources as wind and water and developed to atomic energy and sources that are untrapped at the present. The student will be able to experiment with many of the facets of power development. The experiences will be highly experimental in nature, yet realistic in terms of applicability.

I. Natural sources of power
   - A. Man and beast
   - B. Wind
   - C. Water
   - D. Solar

II. Mechanical sources of power
   - A. Levers
   - B. Wheel and axle
   - C. Incline plane
   - D. Screw
   - E. Wedge

III. Control and use of various forms of energy
   - A. Development of steam power
   - B. Development of internal combustion engine
   - C. Development of electrical energy
   - D. Development of atomic and solar energy
   - E. Development of geothermal energy
   - F. Future power sources

IV. Work, energy, power
   - A. Work
     1. Definition of
     2. Measurement of
   - B. Energy
     1. Definition of
     2. Kinds of
        - a. Potential
        - b. Kinetic
   - C. Power
     1. Definition of
     2. Measurement of
     3. Horsepower
        - a. Definition
        - b. S. A. E.

WATER AS A SOURCE OF POWER

I. Early use of water
   - A. Float rafts
   - B. Use of sails

II. Waterwheels
   - A. Undershot waterwheel
     1. "Impulse" waterwheel
        - a. First engines designed to do work
        - b. First machine substituted for animal power
     2. The Vitruvian mill
   - B. Overshot waterwheel
     1. John Smeaton, 1750.
     2. Water brought over top of wheel
     3. Velocity and weight of water produced moderate speed and power.
   - C. Breast wheel
     1. Origin not determined
     2. Water directed down into wheel
   - D. Improved wheel
     1. General J. V. Poncelet, 1824.
     2. Concave curved blade facing upstream
     3. First reaction waterwheel

III. Water turbines
   - A. The Barker mill, 1743.
   - B. Benoit Fourneyron, 1823.
     1. Reaction water turbine
   - C. Modern water turbines
     1. Rotors enclosed in housing with water directed to them by pipes or gates
     2. "Head" or pressure built up by damming or elevated reservoirs.

IV. Applications of water power
   - A. Past
     1. Waterwheels first used to grind wheat and corn
     2. Refinement produced wheels with greater power for mills & manufacturing
   - B. Present
     1. Development of steam engine freed industry from water locations resulting in obsolescence of the waterwheel
     2. Development of water turbine led to construction of many hydroelectric power plants. About 20% of all electricity produced by water turbines.
   - C. Future
     1. Development of "pumped hydro storage" plants will lead to more hydroelectric power.
     2. Turbine used as pump to raise water to develop "head" or pressure.

STEAM TURBINES

I. Development of steam turbines
   A. Hero - 1st century A.D., Alexandria, Egypt
   B. Giovanni Branca, 1629.
      1. Designed simple turbine to operate small pounding mill.
      2. Jet of steam directed against vanes attached to rim of horizontal wheel.
   C. Gustav DeLeval, 1845.
      1. Further developed Branca turbine to build a centrifuge to separate cream from milk.
      2. Used many steam nozzles to direct steam against vanes producing high speeds.
   D. Charles Parsons, 1884.
      1. Parsons given credit for being first to use turbines for marine transportation and for stationary use in electric dynomos.
      2. Used fifteen sets of blades on each side of steam entrance.
      3. Permitted steam to expand to drive rotors resulting in greater force and more power.
      4. From this developed multi-stage turbine

II. Types of steam turbines, their design and structure
   A. Impulse turbines
   B. Reaction turbines
   C. Compound turbines
   D. Centrifugal force
      1. Rotors
   E. Steam leakage
      1. End-tightening
      2. Rotor shaft leakage
   F. Journal bearings
   G. Governors
      1. Two governors generally used on each turbine
      2. Turbine regulated by controlling quantity of steam.
      3. One governor regulates rotor speed and prevents runaway.
      4. Second governor regulates governor speed but also acts as automatic shut-off in case of emergencies.

III. Applications of steam turbines
   A. 80% of electric generators run by steam turbines
   B. Steam turbines used to power marine craft
   C. Steam turbines used to produce electricity to run electrically powered marine craft.
   D. Steam turbines used in nuclear powered marine craft, including submarines and nuclear electric generating plants.

WIND AS A SOURCE OF POWER

1. Removal of chaff by wind when grain tossed into the air
2. Increasing heat from a fire
3. Sailing log rafts and then boats
4. Early use of wind mills by the Dutch
   a. Pumping water
   b. Grinding grain
   c. Variable vane or blades
5. More recent use of wind
   a. Seebee washing machines during WW II
   b. Wind generators in isolated areas to provide electricity
      (1) Emergency
      (2) Regular power
6. Modern use is fixed vane with variable rotor to face the wind
7. Pump water for range live stock
8. Emergency power for modern aircraft
   a. Propeller driven generators
   b. Turbine driven generators

MEASUREMENT - WORK, ENERGY, & POWER

I. Work
   A. Work = force X distance
      1. Force = weight in pounds
      2. Distance = distance in feet
   B. Work = feet - pounds

II. Energy
   A. Potential
      1. Position
      2. Condition
      3. Chemical state
      4. Potential energy = force X distance
   B. Kinetic
      1. Energy of motion
      2. Law of energy conservation
      3. Machine efficiency
         a. Efficiency = $\frac{\text{output}}{\text{input}}$ X 100
         b. Efficiency = input - losses X 100
         c. Efficiency = $\frac{\text{output}}{\text{output}}$ + losses X 100

III. Power
   A. Definition
      1. Rate of work
      2. Rate of energy
   B. Measurement
      1. Power = $\frac{\text{work}}{\text{time}}$

2. Horsepower
   a. Horsepower = $\frac{\text{work}}{\text{time (in seconds)}} \times 550$
   b. Horsepower = $\frac{\text{work}}{\text{time (in minutes)}} \times 33{,}000$

ENGINE MEASUREMENT

I. How engine size is measured
   A. Horsepower
   B. Torque
   C. Cubic inch displacement
II. Piston displacement
   A. Definition
   B. Determining factors
      1. Bore
      2. Stroke
   C. Determining displacement with formula
   D. Compression ratio
      1. Definition
      2. Commonly used ratios
         a. Gasoline engine
         b. Diesel engine
      3. Compression, raising, lowering
         a. Effect on power
         b. Effect on economy
      4. Fuel

RECIPROCATING STEAM ENGINES

I. Hero
   A. Ancient inventor
   B. Aeolipile
II. Worcester
   A. Water commanding engine
   B. Savery improvement
III. Newcomen
   A. Piston
   B. Pump
IV. Watt
   A. Condensor
   B. Double-acting engine
   C. Efficiency
V. Pickard
   A. Watt's rival
   B. Reciprocating to rotary
VI. Fitch
   A. Steamboat
   B. Unsuccessful
VII. Fulton
   A. Successful steamboats
   B. Models

VIII. Cugnot
- A. Steam carriage
- B. "Gun tractor"

IX. Century of power for
- A. Factories
- B. Ships
- C. Locomotives
- D. Tractors
- E. Steam rollers
- F. Steam shovel
- G. Steam trucks

ATOMIC POWERED GENERATORS

I. The development of steam turbines
- A. Basic turbine parts and their function
- B. Different types of steam turbines
  1. Impulse turbine
  2. Curtis turbine
  3. Reaction turbine

II. Principles of turbine engines in operation
- A. Rotary action vs. reciprocating
- B. For every action there is an equal but opposite reaction.

III. Atomic energy for producing steam
- A. Comparison of power potential of uranium to coal.
  1. 1 pound of uranium (size of golf ball) is equal in power to 3,000,000 pounds of coal. (about 25 railroad cars full of coal)
- B. Nature of matter
  1. Breakdown of atom into basic parts (proton, neutron, electron)
- C. Atomic fission
- D. Nuclear reactor
  1. Basic components and their functions.
     a. Atomic fuel, uranium U-235.
     b. Control and safety rod mechanism
     c. Water pipes

IV. Comparison of atomic powdered steam generator with conventional fossil fuel boiler.
- a. Clean burning reactor takes the place of air polluting fossil fuel.
- b. Heat exchanger takes the place of conventional boiler.
- c. The other main components; pump, condensor, turbine, and method of electrical distribution are the same.

INTERNAL COMBUSTION CONVERTERS

(RECIPROCATING TYPE)

I. Development or construction of small gasoline engine
   - A. Basic engine parts
   - B. Four-stroke engine
   - C. Two-stroke engine

II. Lubrication
   - A. Quality of oil - SAE numbers - friction
   - B. Simple splash system
   - C. Ejection pump system - barrel type pump
   - D. Lubrication of engine - walls - blowby
   - E. Lubrication of 2 cycle engines

III. Fuel system
   - A. Suction and gravity type
   - B. Carburetor and adjustments of high speed and low speed
   - C. Governors and mechanical throttles

IV. Cooling system
   - A. Air cool system and care of system
   - B. Water cooling system - outboard engines and inboard engines

V. Ignition system
   - A. Basic magneto parts
   - B. High tension coils
   - C. Breaker points - condenser-plug and cable
   - D. Magneto ignition for more than one cylinder
   - E. Engine timing - camshaft

VI. Care of and maintaining engine
   - A. Oil change - filter - plug - storage - checklist before starting
   - B. Special problems on inboard and outboard engines

VII. Trouble-shooters
   - A. Engine tune-up
   - B. Reconditioning engine - valves - timing - gaskets replacements -

COMPRESSION IGNITION ENGINES

I. History
   - A. Rudolph Diesel
     1. Engineer
     2. Explosion
     3. 1897 success
   - B. Stationary
     1. Replaced steam
     2. Heavy
        - a. 250 pounds per horsepower
        - b. Immobile

II. Comparison to spark ignition
    A. Compression
        1. 10 to 1
        2. 17 to 1
    B. Fuel
        1. Carburetion
        2. Injection
            a. Fuel
            b. Air
    C. Weight
        1. Light
        2. Heavy
    D. Governor
        1. Optional
        2. Mandatory
III. Operation
    A. Four-stroke cycle
        1. Intake
            a. Air drawn
            b. Blown
            c. No carburetor
        2. Compression
        3. Power
            a. Compression ratio
            b. Fuel injection
        4. Exhaust
    B. Two-stroke cycle
        1. Compression
            a. Air blown
            b. Compression
        2. Power
            a. Fuel injection
            b. Exhaust
IV. Fuel injection
    A. Operation
        1. Each cylinder
        2. Cylinder
        3. Plunger
        4. Exact tolerances
        5. 3,000 to 30,000 pounds pressure
        6. Metering
    B. Types
        1. Common rail
        2. Pump
        3. Unit
        4. Distributor
        5. Parker
    C. Chamber designs
        1. Open
        2. Auxiliary
        3. Precombustion
        4. Air cell
        5. Energy cell

V. Air blower
   A. Roots blower
   B. Loop system
VI. Application
   A. Locomotive
   B. Marine
   C. Trucks
   D. Busses
   E. Automotive
   F. Road machinery
   G. Stationary power

AIRCRAFT PISTON ENGINES

I. Cylinder arrangement
   A. In-line engine
   B. V-type engine
   C. W-type engine
   D. X-type engine
   E. Radial-type
   F. Opposed-type
   G. Replacement "jugs"
II. Horsepower rating
   A. Brake
   B. Low RPM
III. Requirements of power plant
   A. Reliability
   B. Low weight per horsepower
   C. Economy of operation
   D. Flexibility
   E. Balance
IV. Cooling
   A. Air
   B. Liquid
V. Lubrication
   A. Must be at all moving points
   B. Pressure-gear oil pump
   C. Scavenger pump
VI. Ignition system
   A. Battery
   B. Magneto
   C. Dual - two systems of the same type
VII. Internal combustion, four cycle, overhead valves engine.
VIII. Propeller
   A. Direct to crank shaft
   B. Reduction gear
IX. Connecting rods
   A. Not all the rods are the same size in the same engine.
   B. Radial engine has one throw on crankshaft--all rods fit on this throw.

GAS TURBINE ENGINES

I. Introduction
   A. History and development of gas turbine engines
II. Gas turbine and turbojet propulsion engines
   A. Distinction between the gas turbine and turbojet propulsion engine
   B. Air-dependent engine
III. Regenerative gas turbine
   A. Air inlet
   B. Compressor
   C. Combustion chamber
   D. Regenerative drums
   E. Gasifier turbine
   F. Power turbine
IV. Gas turbine systems
   A. Fuel system
   B. Electrical system
   C. Lubrication system
   D. Ignition system
V. Gas turbine applications
   A. Large land wheeled vehicles (buses, trucks, etc.)
   B. Automobiles
   C. Helicopters and small aircraft
   D. Marine use
   E. Process industries
   F. Electrical generation
   G. Multipurpose use
VI. Advantages of gas turbine engines
   A. Size and weight per horsepower
   B. Require inexpensive fuel
   C. Easy to maintain
   D. Aircooled
   E. Fewer moving parts
   F. Easy starting in cold weather
   G. Non polluting
   H. Will not stall under overload
   I. No warm up period required
VII. Disadvantages of present gas turbine engines
   A. Excessive fuel consumption
   B. Most efficient only at top speed
   C. Expensive to manufacture at this time
VIII. Auto and heavy vehicle gas turbine engine development
   A. Chrysler A-831 gas turbine (automobile)
   B. General Motors GT-305 gas turbine (automobile)
   C. General Motors GT-309 gas turbine (trucks)
   D. Ford 707 gas turbine (trucks)
IX. Aircraft gas turbine engine development
   A. Allison 250 turboshaft engine
   B. Avco T-53 turboshaft engine
X. Principles of jet propulsion
   A. Hero's aeolipile
   B. Newtons third law of motion
   C. Thrust developed in combustion chamber
   D. Measurement of thrust

XI. Turbojet engine components
    A. Air inlet
    B. Compressor
        1. Axial flow
        2. Centrifugal flow
    C. Combustion chambers
    D. Turbine
    E. Exhaust cone
    F. Tailpipe
    G. Afterburner
XII. Turbojet systems
    A. Fuel system
    B. Electrical system
    C. Lubrication system
    D. Ignition system
XIII. Other types of turbojet engines
    A. Turboprop
    B. Turbofan
XIV. Other jet propulsion engines
    A. Ramjet
    B. Pulsejet
XV. Occupational opportunities

GAS TURBINE REACTION ENGINE

I. History
    A. History in United States
        1. The Charles G. Curtis patent, 1914
        2. The Frank Whittle patent, 1930
        3. Other patents and developments for electricity, aircraft, and locomotives.
        4. Dr. Adolf Meyer patent and design for gas turbine adaption to locomotives. (electric)
    B. Development
        1. Steam
        2. Gas
        3. Conversion from steam to gas
            a. Development by Armengaud and Lemale
                (1) Methods used in its development
    C. Military developments
        1. Aviation and marine
            a. Jet engines
            b. Rocket engines
II. Types of gas turbines
    A. Two main cycles of air circulation
        1. Open cycle
        2. Closed
    B. Component parts in open cycle
    C. Component parts in closed cycle
III. Characteristics of turbines
    A. Two sections
        1. Gasifier
            a. Compressor and combustion chamber

2. Power turbine
    a. Conversion of energy from first section into mechanical energy - direct and indirect
3. Gear train
    a. Conversion of gas to energy
    b. Helicial gears and reduction

B. Main types of gas turbines
1. For land vehicles
2. Reaction - propelled A/C
3. Stationary
4. Multipurpose

C. Advantages of gas turbines as a prime mover
1. Weight to power ratio
2. Simplicity in number of parts
3. Size per horsepower
4. Multifuel capability
    a. Any liquid hydrocarbon

D. Principles of operation and function
1. Four phase principle
    a. Air intake
    b. Air compression
    c. Air expansion
    d. Air exhaust
2. The continuous phases - the thermodynamic difference - gas is heated continuously

IV. Basic component parts of gas turbine
A. Turbine nozzle (hydraulic servo unit)
1. Nozzle blades (variable)
2. Turbine wheel
3. Impeller (blades)
4. Diffuser
5. Compressor
6. Burner

B. Compressor - two types (turbine)
1. Centrifugal - flow
2. Axial - flow

C. Regenerator (scavenger)
1. Thermodynamic requirements
    a. Steam
    b. Nuclear
2. Definition and explanation of heat exchanger

D. S eds (R.P.M.) of integral parts of turbines
(ch of above parts are all turbine principle)

E. Accessories used on turbine
1. Fuel
2. Electrical
3. Hydraulic
4. Starter
5. Other

F. Types of fuels used
    1. Hydrocarbons, all
    2. Availability of fuels
    3. Climatic conditions

V. Adaptive uses of turbines
    1. Car
    2. Truck
    3. Aircraft
    4. Locomotive
    5. Marine
    6. Stationary power units

VI. Comparison of turbine with other types of power units
    A. Advantages
        1. Maintenance
        2. Fuel consumption
        3. Lubrication
        4. Weight
        5. Basic cost
        6. Climatic conditions (starting)
        7. Cooling systems
        8. Over all continuous operation
        9. Number of moving parts
        10. Electrical systems
        11. Exhaust fumes (pollution) control
        12. Overloads
        13. Maximum R.P.M.

ROCKET ENGINES

I. History of rockets
    A. Chinese
    B. Goddard
    C. German rocketry

II. Rockets in space
    A. Russian development
    B. United States development
    C. Dyna-soar program
    D. Apollo space program

III. Rocket engine operation
    A. Newtons third law-for every action there is an equal and opposite reaction.
    B. Air-independent motor
    C. Carries both fuel and oxidizer
    D. Nozzle design affects thrust

IV. Liquid propellent rocket engines
    A. Fuels
    B. Storage tanks
    C. Feed systems
        1. Gas pressure
        2. Turbo pumps
    D. Injectors
    E. Combustion chamber (convergent-divergent nozzle)

V. Advantages of liquid rocket engines
   A. Can be controlled in flight
   B. Greater impulse or thrust
   C. Long range
VI. Liquid rocket engine aircraft development
   A. U.S. AIRFORCE X-15
      1. Miles per hour
      2. Altitude
VII. Solid fuel rocket engine
   A. Principal action same as liquid propellant rocket
VIII. Chemical propulsion
   A. Significant design feature is its star shaped grain design.
   B. Common propellents
      1. Ballistite (nitroglycerine and nitrocellulose)
      2. Gallit (asphalt oil mixture and potassium perchlor)
IX. Solid rocket engine classification
   A. Restricted burning
   B. Unrestricted burning
X. Controlled burning characteristics
   A. Progressive burning
   B. Regressive burning
   C. Neutral burning
XI. Advantages
   A. Low toxicity
   B. Simple to construct
   C. Economical
   D. Dependable
XII. Disadvantages
   A. Lower thrust
   B. Decomposition
   C. Cracking
XIII. Model rocket project
   A. Designing
   B. Fabrication (assemble from kits)
   C. Stability testing
   D. Launching
   E. Tracking
   F. Compiling flight data
   G. Experimenting
   H. Safety

PETROLEUM FUELS

I. Crude oil
   A. Refined into gasoline
   B. Origination
      1. Animal and vegetable substances
II. Fractionating tower
   A. Thermal cracking
   B. Catalytic cracking

III. Volatility
  A. Rate of evaporation
  B. Gasoline is blended
IV. Common fuels
  A. Advantages of gasoline
  B. Diesel
  C. Kerosene
  D. L.P. gas
V. Combustion
  A. Gasoline
    1. Carbon and hydrogen
    2. Oxygen, nitrogen, and other gases
    3. Carbon monoxide
    4. Carbon dioxide
    5. Water (as steam)
    6. Temperature of combustion
  B. Diesel
    1. Carbon monoxide
VI. Detonation (knock or ping)
  A. Compression
  B. Results of detonation
    1. Power loss
    2. Over heating
    3. Damage to engine parts
  C. Carbon build-up
VII. Octane rating
  A. Ability of gasoline to resist detonation
  B. Asphaltic base compared to paraffine base
  C. Cracked gasoline
  D. Iso-octane
  E. Effect on combustion
  F. Dye
VIII. Additives
  A. Oxidation inhibitors
  B. Antirust agents
  C. Detergents
  D. Phosphorus
IX. Vocational opportunities
  A. Oil fields
  B. Refineries
  C. Distribution
    1. Wholesale
    2. Retail

LUBRICATING OILS

I. Essentials and characteristics of lubricating oils
  A. Engine oil is expected to primarily lubricate
    1. Bearings
    2. Gears
    3. Cylinder and piston walls
    4. Cams
    5. Valve stems
    6. Operate satisfactorily as a fluid to operate hydraulic valve lifters

B. Remove heat from the inside of the engine
C. Absorb shock between bearings and other engine parts
D. Seal spaces between the piston and the cylinder wall to prevent blow by
E. Cleans the metal parts and holds in suspension any dirt and metallic and carbon particles
F. Lubrication reduces power loss because it cuts down on friction

II. Sources of lubricants
A. Like gasoline oil is made from petroleum
1. Petroleum
a. Oily
b. Inflammable liquid
c. Almost colorless to black in color
d. Consists of hydrocarbons
2. Lubricants
a. Liquid-engine oil
b. Semi-liquid - chassis lube
c. Solid-graphite (dry products)
B. Refining process
1. Heating process
a. Most volatile parts form gasoline
b. Less volatile parts form engine oils down to tar
2. Condensing the volatile gases and obtaining the different parts of the petroleum

III. Purpose of additives in oil
A. Resistance to carbon formation
1. Prevents oil from burning which causes the carbon
2. Carbon formation or build up in an engine causes:
a. Poor engine performance
b. Sticking rings in pistons
c. Excessive oil consumption
d. Fouls spark plugs
e. Carbon may clog up engine oil lines
B. Oxidation inhibitors
1. Oxidation occurs when engine oil is heated in the engine to fairly high temperatures and then agitated, the oxygen in the air combines with the oil oxidizing it.
2. A small amount of oxidation does no harm
C. Corrosion and rust inhibitors
1. Corrosion inhibitors inhibit corrosion
2. Rust inhibitors
a. Displace water from metal surfaces so that oil coats them
b. They have an alkaline reaction that neutralizes combustion acids

D. Foaming resistance
   1. Tends to overflow and lost through crankcase ventilator
   2. Foaming oil will not provide normal lubrication of bearings
   3. Foaming oil in hydraulic valve lifters causes them to function poorly, work noisily, wear rapidly, possibly break
E. Detergent-dispersants
   1. Detergents act as soap to clean engine
   2. Dispersants keep the dirt from collecting which would form large particles

IV. Service designation of oils
A. Oil is classified according to viscosity number
   1. Viscosity-determined by use of a viscosimeter
   2. Determines the length of time required for a definite amount of oil to flow through an opening of a definite diameter
B. SAE-Society of Automotive Engineers
C. Ranges
   1. SAE 5 - SAE 70
   2. The higher the number the longer it takes to flow
   3. Winter grades have a W after the number
      a. SAE 5W
      b. SAE 10 W
      c. SAE 20W
   4. Winter oils are tested at 0 degrees and 210 degrees
D. Multi-purpose oil
   1. Multiple rating - equivalent in viscosity to several single-rating oils
E. American Petroleum Institute grades oils according to type of service
   1. Spark igniting engines
      a. ML light to moderate service
      b. MM moderate to severe service
      c. MS unfavorable conditions
   2. Diesel engines
      a. DG normal diesel service
      b. DS severe diesel service

EMERGING NEW ENGINE DESIGN

I. The development of the rotary combustion engine
A. Basic engine parts and their function and purpose.
B. Some basic elementary backgroud on rotating combustion engines.
C. Felix Wankel

II. Principles of the rotary engine on operation
A. Basic cycle of intake, compression, power and exhaust.

B. Occurence of pattern of intake, compression, power and exhaust
C. Basic construction and the configuration of rotary engine

III. Operating cycles and design of rotary engine
A. Components of the rotating combustion engine
1. Effective seals - lubrication and parts of ignition - cooling
B. Performance of engine
1. Brake horsepower
2. Torque
3. Speed
C. Operation of engine
1. Smoothness
2. High horsepower to weight ratio
3. Fuels cheap and different fuels can be used
4. Wider speed range
5. Good torque
6. Economical
7. Less wear and fewer parts

IV. The Minto engine
V. The Sterling engine

ELECTRICAL POWER

CONVENTIONAL ELECTRICAL CONVERTERS

I. Introduction
   - A. Effect of electricity on our lives
   - B. History of electricity

II. Principles and theory
   - A. Electron theory
   - B. Magnetism and magnets
   - C. Electro magnetism

III. Electrical safety
   - A. Attitudes
   - B. Practices

IV. Production of electricity
   - A. Heat
   - B. Light
   - C. Pressure
   - D. Friction
   - E. Chemical
   - F. Magnetism

V. Properties of electricity
   - A. Voltage, AC & DC
   - B. Current
   - C. Resistance

VI. Electrical measurements
   - A. Voltmeter
   - B. Ammeter
   - C. Ohmmeter
   - D. Wattmeter

VII. Circuits
   - A. Series
   - B. Parallel
   - C. Series parallel

VIII. Ohm's law
   - A. Series circuit calculations
   - B. Parallel circuit calculations
   - C. Series/parallel circuit calculations

IX. Introduction to work area
   - A. Parts
   - B. Safety
   - C. Care
   - D. Techniques
   - E. Electrical tools

X. Generators
   - A. AC
   - B. DC

XI. Capacitors
   - A. Purpose
   - B. Use

XII. Transformers
   - A. Step-up
   - B. Step-down

XIII. Motors
   - A. AC
   - B. DC

XIV. Electrical symbols
XV. Control devices
  A. Switches
  B. Rheostats
  C. Relays
  D. Thermostats
XVI. Solid state devices
XVII. Occupational opportunities
  A. Professions
  B. Vocations
  C. Educational requirements

SPARK IGNITION ENGINES

I. Principles and operation of electrical ignition systems
  A. Electron theory
  B. Units of electrical measurement
    1. Ampere
    2. Volt
    3. Ohm
  C. Conductors and insulators
  D. Magnetism
  E. Basic magneto parts
    1. Permanent magnets
    2. High tension coil
    3. Laminated iron core
    4. Breaker points
    5. Breaker cam
    6. Condenser
    7. Spark plug cable
    8. Spark plug
    9. The complete magneto cycle
  F. Spark advance-manual and automatic
  G. Impulse coupling
  H. Multi-cylinder engines
  I. Engine timing
  J. Troubleshooting
  K. Safety
II. Applications of spark ignition engines
  A. Lawn mowers
  B. Tractors
  C. Motorcycles
  D. Motorbikes
  E. Motor scooters
  F. Chain saws
  G. Outboard motors
  H. Go-carts

FLUID POWER

HYDRAULICS

I. Introduction
   A. Effect of hydraulics on our lives
   B. History of hydraulics
II. Principles of hydraulics
   A. Pascal's law
   B. Force, pressure, area formula
   C. Compression of liquids
   D. Transmission
III. Hydraulic systems
   A. Power input
      1. Types of liquids
      2. Reservoir
      3. Pumps
         a. Piston
         b. Gear
         c. Centrifugal
      4. Accumulators
   B. Control
      1. Check valves
      2. Directional control valves
      3. Relief valves
      4. Regulators
      5. Flow control valves
   C. Transmission
      1. Hose, tubing, and couplings
      2. Effects of hose size and bends
      3. Hydraulic packings and seals
   D. Power output
      1. Cylinders
      2. Motors
      3. Gain in force or speed
   E. Indicating devices
      1. Pressure gauges
         a. Direct
         b. Remote
      2. Fluid quantity indicators
   F. Hydraulic systems
      1. Open circuits
      2. Closed circuits
      3. How hydraulic systems accomplish jobs.
         a. Heart and veins
         b. Aircraft
         c. Industry
   G. Safety
   H. Job opportunities in hydraulics

PNEUMATICS

I. Definitions
II. Pascal's law, Charle's law
III. Effect of heat on gas
IV. Everyday uses of pneumatics
V. Components of pneumatic system
    A. Pump or compressor
        1. Centrifugal
        2. Rotary
        3. Cooling the pump or compressor
    B. Reservoir or storage cylinder
    C. Hose or pipe
    D. Valves, types
    E. Motor
        1. Air cylinder
        2. Turbine motors
    F. Filters
VI. Pneumatic circuit design
VII. Vocabulary

TRANSPORTATION TECHNOLOGY

(Ref: "The Transportation Division", A Curriculum To Reflect Technology, Epsilon Pi Tau, Inc. Columbus, Ohio 1965 pp-26-30)

LAND TRANSPORTATION

I. Highway
- A. Automotive, history
  - 1. Highway transportation
    - a. Carriages
    - b. Stage coaches
    - c. Early "horseless carriages"
    - d. Famous men - Ford, Kettering, Bentz, others
- B. Automotive, types: pleasure, commercial
- C. Automotive, power plants: gasoline, Diesel, electric, steam
- D. Gasoline engine, automotive
  - 1. Theory of operation: 2-cycle, 4-cycle
  - 2. Fuel system: carburetion-theory
  - 3. Ignition system
  - 4. Electrical system
  - 5. Cooling system
  - 6. Lubrication systems
  - 7. Mechanical
- E. Diesel engines
- F. Chassis, structure and design
  - 1. Frame design and bracing
  - 2. Engine mountings. Floating power
  - 3. Transmissions
    - a. Standard, selective gear type, syncromesh
    - b. Hydromatic
    - c. Free wheeling
    - d. Semi-automatic: Vacumatic, Electromatic
    - e. Overdrive
    - f. Transfer cases
  - 4. Clutches
  - 5. Front wheel suspension
  - 6. Rear wheel suspension
    - a. Springs: oil, transverse, lateral
  - 7. Rear axles
- G. Brakes
  - 1. Mechanical
  - 2. Hydraulic
  - 3. Adjustment and repair
  - 4. Brake boosters: vacuum, electric
  - 5. Self-energizing
- H. Shock absorbers: hydraulic, torque rods
- I. Universals and propeller shafts
- J. Modern body structure
  - 1. Streamlined
  - 2. Welded steel
  - 3. Plastic
- K. Tires: care and repair
- L. Economics: cost, depreciation, financing, upkeep
- M. Safety: driver education, maintenance for safety

II. Railroads
- A. History and development
- B. Types
- C. Standard two rail
- D. Steam, oil, coal-fuel
- E. Diesel electric types
- F. Electric
- G. Gas turbine
- H. Miscellaneous types: trolleys, subways, elevated
- I. Passenger cars: pullman, diners, daycoaches
- J. Freight cars: gondolas, refrigerators, tank, cattle, box

III. Highways
- A. History and development
- B. Types of constructions
  1. Earth, gravel, macadam, asphalt, concrete
- C. Methods of construction
  1. Survey of route: preparation, sub-base, base, surface
- D. Construction machinery or equipment
- E. Bridges and culverts
  1. Suspension, cantilever, truss, concrete, slab, arch, timber, trestle, pile, Bascule, lift, swing
- F. Tunnels: hardrock, submarine, snow
- G. Traffic control
  1. Cloverleaf intersections and super-highways
  2. Government regulations
- H. Highway maintenance: repairs, snow removal

AIR TRANSPORTATION

I. Heavier than air
- A. History of the airplane
- B. Types- commercial and military
- C. Gliders
  1. Towed, freight and personnel
  2. Sailplanes: design, construction, control
- D. A theory of flight of gliders and sailplanes
- E. Power plants: gasoline, diesel, jet, rocket
- F. Radial and inline gasoline engines
  1. Theory of operation
  2. General construction features
  3. Features peculiar to each type
  4. Ignition systems: magnetos, boosters
  5. Fuel systems
  6. Lubrication systems
  7. Repair, maintenance and test of above
- G. Fuselage and wings
  1. Design - theory and mathematics

H. Construction: wood, steel, aluminum or alloy
I. Covering
    1. Fabric
    2. Stretched skin construction
    3. Bonded plywood
J. Controls: manual, hydraulic, electric
K. Instruments: engine, flight
L. Propellers
    1. Theory and design
    2. Wood, steel, aluminum alloy
    3. Controllable and variable pitch, constant speed
M. Auto-Gyro: theory, construction
N. Helicopter: theory, types
O. Jet planes: theory, types
P. Rockets
Q. Gasoline turbine

II. Lighter than air
A. History, rigid and non-rigid
B. Non-rigid
C. Rigid
D. Life: hot air, hydrogen, helium
E. Control mechanism
F. Economics: cost, maintenance and efficiency

III. Navigation: celestial, dead reckoning, piloting, radio, maps, charts, compass courses, radar, Lorain

IV. Meteorology
A. Weather
B. Forecasting
C. Instruments-theodolite, barometers, anemometer

V. Airports
A. Location
B. Layout and construction
C. Hangers: maintenance, service and storage
D. Administration buildings

VI. Aerodynamics
A. Wind tunnels
B. Design
C. Physics of flight

SEA TRANSPORTATION

I. History
A. Ancient marine enterprise
    1. Phoenician
    2. Grecian and Roman
    3. Egyptian
B. Modern marine enterprise

II. Carrier types
    A. Sailing ships
    B. Modern ships
        1. Purpose grouping
        2. Power grouping
        3. Other types
III. Ship construction, steel
    A. Plans: line drawings, lofting
    B. Construction methods
    C. Ship hull parts
        1. Keel
        2. Stem and stern
        3. Bottoms
        4. Bulk heads
        5. Decks
        6. Rudders
        7. Cabins and fittings
IV. Power plants
    A. Steam: reciprocating, turbine, fuel-oil, coal
    B. Diesel: 2-cycle, 4-cycle
    C. Gasoline: inboard, outboard
V. Propulsion units
    A. Paddle wheels: stern, side
    B. Screw propeller
VI. Small boat building
    A. Plans and materials
    B. Lofting and construction practices
    C. Boat types
        1. Sail
        2. Motor: inboard, outboard
VII. Model making
    A. Plans and blueprints
    B. Tools and materials
    C. Types of models
        1. Historic
        2. Sailing working
        3. Motor-gas engines, steam engines
    D. Construction methods
        1. Lifts, bread and butter
        2. Framing and planking
        3. Moulded plastic
    E. Sails
    F. Gas motors
    G. Steam plants
    H. Propellars
    I. Fittings and hardware

SEA: TERMINALS, ROUTES, ORGANIZATION, DOCUMENTS

I. Water terminals and ports
    A. Port functions
    B. Administration
    C. Physical and geographical advantages
    D. Construction and maintenance

II. Piers and quays: wharf design, structural consideration
III. Mechanics of ship discharge
    A. Freight: bulk cargo, liquids
    B. Passenger: customs
IV. Water routes
    A. Ocean routes
    B. Inland water routes
        1. The Great Lakes of North America
        2. River systems
        3. Ship canals
V. Navigation
    A. Ocean navigation
    B. Inland navigation
    C. Rules of the road: safety regulations
VI. Line organization
    A. Freight traffic department
    B. Passenger traffic
    C. Tramp and shipbroker organization
VII. Rates and charges
VIII. Shipping documents
    A. Shipper's papers
    B. Ship's papers: ownership, articles, registry, clearance
    C. Marine insurance: hull, cargo and personnel
    D. Government aid and regulation

TYPICAL RESOURCE UNITS

(YEAR-LONG PROGRAM)

UNIT ON CONVENTIONAL ELECTRICAL CONVERTERS

Introduction to the Unit

This unit requires nine weeks of instruction in a laboratory environment. The student will be introduced to modern concepts of electricity as well as the historical development of these concepts. The unit includes basic information about electrical tools, materials, and industrial processes common to electrical work. The student will become familiar with hand tools through experiments and electrical projects in the lab as well as home projects.

Research, discussion, and outside interviews will enable the student to learn of the many job opportunities in the electrical industries.

The experimental activities will show the close relation between industrial arts and science and thus, through practical experience, help the student to understand better the scientific principles involved. Theoretical material is, whenever possible, followed by one or more examples of its application to the operation of a common electrical device. In this way theory and practice reinforce each other. Approximately 45 days will be allocated to the unit activities.

Safety and careful work habits are continually stressed throughout the entire unit.

BEHAVIORAL OBJECTIVES

Students will be able to:

1. Recall 10 safety rules for electricity laboratories.
2. Draw an electrical historical tree of inventors and inventions.
3. Demonstrate understanding of electrical theory with laboratory projects.
4. Demonstrate a good safety attitude through work practices in class.
5. Perform 3 of 6 demonstrations of electricity production.
6. Identify the properties of electricity from a list of definitions.
7. Demonstrate an understanding of electrical measurements through the use of multimeters and test circuits.
8. Construct series, parallel, and series/parallel circuits.

9. Solve Ohms law problems.
10. Demonstrate the proper use and care of tools and instruments.
11. Construct a generator that works.
12. Recall the purpose of capacitors.
13. Construct a small electric motor that works.
14. Identify 8 of 10 electrical symbols.
15. Construct a pictoral circuit containi . s itches, rheostats, relays, and thermostats.
16. Write a career report based on library research and personal interv ews.

LESSON OUTLINE

I. Introduction
   A. Effect of electricity on our lives; home, school, recreation, hospital, industry, and space.
   B. History of electricity
      1. 600 B.C. Thales of Greece - amber
      2. 62 A.D. Plinty of Rome - loadstone
      3. 1600 William Gilbert - amber
      4. 1700 positive and negative charges
      5. 1750 Ben Franklin - lightning
      6. 1780 Cavendish - conductors, iron
      7. 1800 Volta - chemical electricity
      8. 1803 Dalton - atomic theory
      9. 1815 Davy - mine lamp
      10. 1819 Oersted - electromagnetism
      11. 1830 Marie Ampere - Ampere
      12. 1836 Morse - telegraph
      13. 1850 Faraday - induction
      14. 1852 Henry - induced current
      15. 1854 Simon Ohm - Ohm'
      16. 1876 Bell - telephone
      17. 1882 Edison - lights
      18. 1895 Marconi - transmitter
      19. 1928 Zwarykin - television
      20. 1946 Bratlain - transistors
II. Principles and theory
   A. Electron structure
      1. Atom
      2. Electron
      3. Proton
      4. Neutron
   B. Magnetism
      1. Permanent magnet
      2. Electron orbit pattern
      3. Poles
      4. Magnetic field
      5. Making magnets
      6. Uses of magnetism
      7. Temporary magnets

a. Electromagnet
b. Solenoids

8. Electromagnets
   a. Solenoids
   b. Relays
   c. Motors

III. Electrical safety
   A. Attitudes - desire to work safely, respect safety rules, develop safe work habits.
   B. Practices: clean work area, proper tools, follow instructions, use safety equipment

IV. Production of electricity
   A. Heat - thermocouple, two kinds of metal heated
   B. Light - photoelectric - phototube, solar cell-earth satellite radio.
   C. Pressure - piezoelectric, phonograph
   D. Chemical - dry cell, wet cell, voltaic pile
   E. Magnetism - generator, mechanical energy to electrical, wore-magnetic field - induction.
   F. Alternator - A.C. current, slip rings, commutator, field winding, armature.

V. Properties of electricity
   Voltage (A.C., D.C.) current, resistance, conductors, insulators, measurements, formulas

VI. Electrical measurements
   Voltmeter, ammeter, ohmmeter, wattmeter. Meter movement, shunts, meter connections, VTVM.

VII. Circuits
   A. Series - current flow in single path, resistance additive.
   B. Parallel - current flows in 2 or more paths, resistance total is less than smallest resistor, household wiring.
   C. Series/parallel - combination of A and B.

VIII. Ohm's law
   A. $E = IR$, $I = \frac{E}{R}$, $R = \frac{E}{I}$
   B. E = electramotive force measured in volts
   C. I = intensity of current flow measured in amperes
   D. R = resistance to current flow measured in ohms
   E. Power = E X I

IX. Introduction to work area
   A. Safety
      1. Habit of caution
      2. Clean and orderly
      3. Proper tools
      4. Follow instruction on equipment
      5. Safety goggles, shield, ground wire
      6. Scuffle and practical jokes
      7. First aid for all injuries
      8. Fire exits and extinguishers
      9. Chemicals use and storage
      10. Electrical shock

B. Parts and tools - location, care, and use
C. Techniques - skill through job knowledge and practice

X. Generators - changes mechanical energy to electrical
A. Oersted, Faraday and Henry
B. Electromagnet induction - wire moved in a magnetic field
C. Value of voltage = number of magnetic lines of force moved through, speed of wire through lines of force, and number of wires cutting lines of force.
D. Slip rings and brushes - transmitt AC current from rotating armature
E. DC generators - produce pulsating current
1. Commutator and brushes - pick off DC from armature
2. Voltage strength determined same as AC generators

XI. Capacitors (condensers) stores electrical energy as an electrostatic field
A. Two plates separated by a dielectric
B. Strength = size of plate, distance apart and type dielectric
C. Uses - noise suppressors, surge dampners, voltage doublers, and frequency bypass

XII. Transformers - to increase or decrease voltage intensity while reducing current
A. Construction - two coils of wire different number of turns.
B. Power transferred through magnetic field - mutual inductance
C. Iron core - concentrates line of force
D. Primary winding - source connection
E. Secondary winding - circuit load connection

XIII. Motors - convert electrical energy to mechanical energy
A. AC - current passed through wire causes magnetic field which resist field of permanent magnet
B. Induction and synchronous motors, split phase, capacitor and repulsion induction
C. DC- armature rotates and field is stationary
1. Series - armature and field in series
2. Shunt - armature and field in parallel

XIV. Electrical symbols
A. Conductor
B. Crossing conductors
C. Crossing conductors connectors
D. Switch
E. Bettery
F. Coil
G. Transformer
H. Motor
I. Resistor
J. Transistor

XV. Control devices
  A. Switches - to open and close circuits
    1. Single pole
    2. Double pole
    3. Mercury
    4. Automatic
  B. Rheostats - variable resistors to limit voltage current
  C. Relays - automatic switches electrically operated
  D. Thermostats - variable resistance due to change in temperature

XVI. Solid State Devices - semi conductors
  A. Germanium, selenium, silicon
  B. Emitter - emits electrons
  C. Base - controls flow
  D. Collector - collects electrons
  E. Small, sturdy, and long lasting, require small amount of power
  F. Rectifiers - permit current flow in one direction

XVII. Occupational opportunities
  A. Professions and vocations and educational requirements. Requirements for various one researched by students in library and after school interviews, reports given to class and discussed.

MOTIVATIONAL TECHNIQUES

Since all humans have an inborn curiosity, there is a natural, concious or unconcious, desire to explore and reveal to oneself the unknown. While every student might not be ready to explore the subject you are presenting at a particular time, it is the task of the instructor to motivate the student to learn a subject at a given time and place.

The first step in enticing a student to learn a subject is to establish oneself as an authority on that particular subject. This can mean many hours of research on the teacher's part to make him feel confident he is an authority in a particilar field. If the teacher is lacking in technical confidence the student immediately senses this and is turned off on the subject unless, he has a relentless desire for knowledge of the subject.

Once you are established as an authority in your field you can entice the student to understand his need for knowledge of a particular subject.

If the unit is on basic electricity why not begin by extinguishing the light and air-conditioning in the classroom well before class. As the students enter an unlighted and hot stale room they will forget all other activities and concentrate or complain about the classroom environment. To reinforce the point, have a movie projector and screen set up. This tactic will make the task of proving the value of electricity to everyone very simple. Another motivation tactic or a continuation of the above is to ask the students to name everything they have seen in the past 24 hours that required electricity.

After the students desire for learning the subject has been elicited, continous reinforcement is required. This reinforcement is best accomplished by associating the lesson to something the student is concerned about, for example, motorcycles, amplifiers for bands, automobiles, go-carts etc. If there is no common ground of interest between student and teacher, transfer of knowledge will not take place. For example, it is shear folly to think that a teacher of another discipline can teach Power Technology if he has no extra-curricular interest or prior training.

The history of electricity can be made more relevant by having the students ask their parents to relate the progress in electricity during their childhood. This will get the family involved in the learning process and make the subject more meaningful to the student.

Principles and theory can be taught more effectively by permitting the student to disassemble electrical components, then ask them to explain how and why they work. The teacher then explains on the spot the how and why's.

There is really no need for expensive trainers. The most effective trainers are the simple ones that are available to most teachers. For example, the production, properties and measurement of electricity is best presented with simple experiments such as simple magnets, iron filings, single cells and coils of wire, scout compass and lemons. Inexpensive kits may be acquired from local crafts stores and booklets of experiments from local agricultural agent 4-H representative.

Simple circuits and projects designed by students are good for lasting and meaningful learning. Inexpensive devices such as the Jacob's ladder, burgular alarms, amplifiers, and a black light, are good.

Students can be encouraged to plan electrical projects for themselves and discuss the fundamental theories of electricity in group projects. The practical projects will help to understand how electrical theories are applied in the fields of power and transportation.

Safety is most effective when the student is made aware of the danger to his own well being. This can be accomplished through film, posters, short lectures, and a quiz. Safety is a subject that must be continually brought to the students attention.

SUGGESTED MATERIALS FOR UNIT

1. Training aids
   a. Silver Burdett Student Laboratory Program
   b. Automotive and household electric motors, switches, relays, generators, batteries, and related circuitry.
   c. House appliances brought in by students
   d. Small engine electric circuits
2. Films:
   a. Story of Storage Battery - Bureau of Mines
   b. Atomic Power Production - Fla. Power
   c. Nuclear Power for ADC - USAF
   d. Electric Propulsion - NASA
   e. The Vacuum Tube - Orange County 4434
   f. Safety with Electric - 4619
   g. What is Electric Current - 8075-9
   h. Current Electricity - 8618
   i. Amperes, Volts, Ohms - 4626
   j. Magnetism - 4277
   k. Electrons at work - 8075-13
   l. The Mighty Atom - 12237
   m. Thomas Edison - 12114
   n. Electromagnets - 4138
3. Equipment and printed material
   a. Dry cell and wet call batteries
   b. Multimeters
   c. Overhead and 16 mm projectors
   d. Wire, resistors, bulbs, and switches
   e. Safety bulletin 76-H-1
   f. 4-H Electric booklets
   g. General Power Mechanics- McGraw Hill
   h. Power Mechanics - McKnight
   j. Power Technology - Stephenson

ELECTRICAL "QUIZ"

1. What is meant by magnetic induction?
2. Upon what three things does the strength of an electromagnet depend?
3. What are the three parts that make up an atom?
4. The rate of electron flow is
   a. Voltage
   b. Amperage
   c. Resistance
   d. Magnetism
5. Total resistance in a series circuit is
   a. Less than the smallest resistor in the circuit
   b. One half the total resistance
   c. The sum of all resistors in the circuit
   d. Measured with a volt meter
6. Producing a current flow by rotating a coil of wire through a magnetic field is accomplished with an electric
   a. Motor
   b. Rheostat
   c. Storage cell
   d. Generator
7. A transformer steps up or steps down which type voltage
   a. D.C.
   b. A.C.
8. A blown fuse is an indication of
   a. Low voltage
   b. High current flow
   c. Wire that is too large
   d. High resistance
9. In case of electrical shock where breathing has stopped, _____ _____ must be started immediately.
10. A galvanometer is an instrument used to measure
    a. Weak electric current
    b. High voltage
    c. Low resistance
    d. Wattage

SECTION D

CAREER ORIENTATION DATA FOR THE INDUSTRIAL ARTS TEACHER

Occupational Clusters &

Interview Reports for the

Power & Transportation

Industries

OCCUPATIONAL CLUSTERS FOR THE POWER INDUSTRIES

Professional classification

- Scientists
- Researchers
- Invèntors
- Engineers
- Corporate management
- Military & civilian officers

Technician classification

- Electronic technicians
- Engineering aids or assistants
- Experimental mechanics
- Repair personnel
- Service personnel
- Draftsmen

Skilled classification

- Specialized equipment sales personnel
- Aircraft mechanics
- Operators of prime movers
- Production personnel
- Linemen
- Auto mechanics
- Machinist
- Tool & die makers
- Middle management personnel

Unskilled classification

- Janitors
- Helpers
- Gas station attendants
- Laborers
- Automobile salesmen

CAREER INFORMATION INTERVIEW

Classification: Professional

Job title: Scientist

Name of employer: Private university

Minimum education: Master of Science

Job description

"As an instructor of Physics; my objectives are:

1. To show the relevance of mathematics to physical science.
2. To promote an awareness of new research especially in industry
3. To insure a basic understanding of the historical aspect which our field is based upon.
4. To instill the concepts of the basic operating principles
5. To view the world in a physical science concept.
6. To advance our physical knowledge."

Pay range:

"The pay range varies from $6,000 to $40,000. An average pay range for education on my level is about $10,000 whereas in industry the comparable employee would probably be earning an additional $2,000 at every point up the line. In an administrative position the earning ratio would be much larger,of course."

Average number of hours spent on the job:

As an educator I spend well beyond eight hours a day six days per week. By contrast, industry is rigidly on a forty hour work week except for some paid overtime from time to time.

Practical experience needed for position:

Good credentials and contributions to the field in the form of many published papers.

Who are your superiors:

At the University, the Chairman of the Department and of course the typical administrative staff are my superiors.

Do you have to work overtime:

Yes, many hours at no extra salary.

What is the opportunity for advancement:

"Advancement is determined by many things. If an individual has a good job performance and performs well in his social setting he should be a department head in at least fifteen years."

What are the specific responsibilities of position:

The two most basic responsibilities the physicist encounters are a constant deadline to meet and the problem of efficiency.

Do you supervise any other personnel?

I only supervise people who are working under an assistantship and instructors of less seniority or experience indirectly, of course.

How are the working conditions?

The working conditions are generally good.

Do you enjoy your work? and why?

Yes, I do what I enjoy. My work is always a challenge and I am constantly dealing with the relationship between theory and practical application.

What are the highlights of your work?

I enjoy most the near completion of a project; the knowledge that I can overcome a challenge.

What are the depressing areas?

Like all jobs, we encounter work which becomes monotonous or personally disinteresting.

Are there professional organizations to help you? Are they really a benefit?

The professional organizations publish new research and techniques which are a valuable and useful asset in my work as well as that of the industrialists.

Classification: Professional

Title: Inventor

Name of company: Local Freeze Dry company

Job description:

To freeze dry chives one needs to have a good working knowledge of food processing and engineering. A degree is not necessary but the

experiences gained would enable one to learn the food industry quicker.

Pay range:

This is a new business and interviewee is making more than he did as a Government Researcher. He works 9 to 10 hours a day, 6 and 7 days per week.

Benefits: It gives a person a sense of satisfaction and accomplishment in knowing that his invention has cut the cost of freezing food by 3/4.

Working conditions:

They are poor as compared to a well equipped shop. It was pointed out that money does not produce the new products or invention but it is the ability of some person to make the idea profitable and usable.

Supervisory capacity:

As an inventor he did not supervise others but as an owner of his company he will supervise his employees.

Opportunities for advancement:

The invention of the new process of freeze drying chives opened the road to many other ideas.

Types of equipment he must be able to operate:

The researcher and developer must be a good laboratory technician and have a working knowledge of engineering and refrigeration. He must be able to do some welding, plumbing, and carpentry.

Classification: Professional

Job title: Associate Manufacturing Engineer

Name of company: Nationally known electric corporation

Minimum education required: High School education and some college credit.

Description of job:

Specify tools and equipment to be used in the manufacture of nuclear powered electrical

generating components.

Pay range:

$700 to $1100 per month salary, no hourly rate.

Average number of hours spent on job:

Hours per day on job are 8 1/2

Practical experience needed for position:

No practical experience needed for job

Who are your superiors?

He works for the Manufacturing Engineering Manager

Do you supervise any other personnel?

He does not supervise any other personnel

How are the working conditions?

Working conditions are good to excellent

Do you have to work overtime?

Works overtime as the workload requires, but does not get paid for it.

What is the opportunity for advancement?

Limited unless converted to a different field.

What are the specific responsibilities of position?

Specification of tools and equipment for manufacture of products.

Classification: Technician

Title: Senior estimator

Name of company: A State Power and Light Company

Job description:

Completion of high school is a requirement for

initial employment. Advancement is determined by ability to achieve junior college or higher education called cooperative education which includes work experience while attending college. Primary job is the collecting and filing of data to be used later by himself to determine future electrical power requirements.

Advantages: primarily an inside desk job with occasional field trips, to be able to use the data collected and filed.

Disadvantages: none, except possibly the necessity of moving in order to obtain his next promotion.

Pay range:

After 5 years is $900 to $1100 per month.

Average number of hours spent on the job:

The hours per day on the job are 9 hours, 5 days per week.

Practical experience needed for position:

Practical experience not needed for the job, only to get it. The job is obtained from on the job plus the cooperative program mentioned above. The company pays all or most tuition.

Benefits:

Retirement benefits start several years after initial employment. There is an annual sick leave determined by the length of service as are the paid vacations. The company pays one half of the employees health or medical insurance.

Who are your superiors?

He works for the senior engineer.

Do you supervise any other personnel?

He supervises two others.

How are the working conditions?

The working conditions are clean, well furnished, well lighted, air-conditioned, parking spaces.

Do you have to work overtime?

Yes, at the rate of 1.5 times regular

What is the opportunity for advancement?

There is ample opportunity for advancement, depending on willingness to take transfers and to comply with the experiences required for district manager. The time required is about twenty years.

What are the specific responsibilities of the position?

To be able to use statistical data in extrapolating future electric power requirements so that plans can be made for furnishing the demand requirement.

Types of equipment he must be able to operate:

The only type of equipment is the use of a teletype to program the company computer.

Opportunities for advancement:

It would probably take 10 years to reach his present position without the two years of college. The other departments have a comparable pay scale; experience plus educational requirements.

Classification: Technicians

Job title: Air condition service personnel

What air conditioning is:

Air conditioning cooling utilizes principles of physics. As a liquid vaporizes, it absorbs heat from whatever is around it. An air conditioning system contains a liquid refrigerant which vaporizes within a cooling coil, getting very cold and absorbing heat from air blown over the coil. The hot vapor goes through a condenser coil, where the vapor turns back into a liquid, giving up its heat to another stream of air. The refrigerant returns to the evaporator coil, where it again turns to vapor, completing the cycle.

Technicians are very necessary to the industry, and their work ranges from the very general to the highly specialized. They may be concerned with research and development of equipment; estimates of size and cost; sales; installation; service and repair;

preparing instructions; or troubleshooting. Responsibilities range from that of engineer to that of a mechanic or helper.

Where do air condition specialists work:

Air conditioning engineers and technicians are employed in every section of the country, in communities and cities of medium to large size. The demand is large in large commercial and industrial centers.

Dealers and contractors in the refrigeration air conditioning business employ a large number of technicians.

Jobs and employment:

Mechanics, technicians, and engineers usually work in one or two of the several phases of air conditioning. In industry, they assist in testing new ideas and equipment for future products or are troubleshooters or salesmen. Those working for a building management service or its owners, generally are concerned with routine service and repairs. Employees of construction companies, contractors, and equipment dealers spend most of their time on installations and servicing. The owner of a business often combines these functions and may add others.

What are the attractions of this work:

Experience qualifies the technician for many top jobs in manufacturing or in commercial service. Many of the most successful dealer-contractors, a large number of whom own their business, began as mechanics or technicians. As knowledge and skill increase, earnings generally keep pace.

There are unattractive features:

Work entails some physical discomfort and possible hazards. Handling heavy equipment causes muscle strain. Often it is necessary to work from awkward, cramped positions in order to reach components that need repair or replacement. Some work must be done from ladders, scaffolding, or other positions at great height. There is always danger from electrical shock or from torch burns.

Personal and technical qualifications:

They need at least average intelligence and the ability to think logically. Technological progress is resulting in equipment that is more and more complex.

Young men who seek training through an apprenticeship must meet requirements of the union. Generally these include an age range of about 18 to 23 for a beginner; high school graduation or its equivalent; passing a physical examination; and passing an aptitude test.

What will be your earnings:

Earnings of most air conditioning technicians are based upon an hourly rate. The standard work week is 40-hours. Remuneration for over-time during summer months is usually at time and a half.

The beginning hourly rate for helpers with no education beyond high school ranges from about $1.25 to $2.00. Top rates for technicans range from $3.00 to $5.50 an hour.

How do you get started in this work:

The demand for workers in the air conditioning industry is great enough to make it fairly easy for a sincerely interested beginner to find work.

The graduate of a vocational high school or technical school usually finds his first job through the placement office of his school. The state employment agency, or a private employment agency usually has listings of air conditioning and refrigeration dealers who need technically trained men.

Many technical schools have placement offices where employers list jobs for which there are vacancies and the requirements for each one.

Classification: Technician

Job title: Service Manager at new car company

Minumum education required for this position is a high school diploma which he holds.

The following is a brief description of the job stating the advantages and disadvantages:

(a) Customer relations--new car warranty satisfaction as per factory, complete charge of personnel (includes paint and body shop.)
(b) Opportunity to accept responsibility, meet the public, and opportunity to exercise judgment.
(c) Being able to find qualified personnel; lack of customer understanding relative to new car warranty are

disadvantages. The pay range for this job extends from $10,000 to $25,000 annually. He spends on the average of 12 hours daily on his job. The practical experience needed for this job was obtained through on-the-job training. Expert mechanical background is not a pre-requisitye. However, working knowledge of automobiles is required.

Benefits are many for this employee: insurance benefits, pension plan, and a car is furnished for his use. There is a minimum 2-week paid vacation and bonuses, both monthly and annually.

Interviewee works for an automobile dealer and at the present time supervises 25 employees. In the very near future when they move into new quarters he will supervise as many as 50 employees. Facilities are described by the employee as "excellent", equipment up-to-date, with management relations excellent.

Overtime work averages 4 hours per day. He works for a weekly salary with additional bonuses paid monthly and yearly. There is no specified hourly rate. There is ample opportunity for advancement to sales manager, then to car lease manager, or perhaps even General Manager.

His overall duties comprise supervising personnel and equipment, coordinating all customer service and maintaining the best in customer relations. He has a working knowledge of all the equipment in the customer service department but does not have to operate such except under unusual circumstances. This man expressed a liking for his work and stressed the need for qualified service managers in Brevard County. There is a current need for 200 to 250 qualified automobile mechanics. The qualified mechanic's average weekly salary is $250.00. Additional benefits not mentioned above is the opportunity to attend schools and also travel for conferences and conventions.

Classification: Technician

Job title: Service technician of National Retail House

Their educational requirement is a high school diploma as a minimum.

This small engine mechanic's job is to trouble shoot, repair, or replace parts.

The company has a profit sharing plan, good fringe benefits (life and medical insurance), paid vacation,

and eight holidays per year were some of the advantages mentioned. There were no disadvantages mentioned at the time of the interview.

A small engine mechanic's salary begins at $2.75 per hour to a maximum of $4.00 per hour, with a work day consisting of eight hours.

Interviewee's good mechanical background was obtained through on-the-job training in the military and practical experience.

Benefits mentioned: profit sharing, insurance benefits, fringe benefits, meeting people, and getting a considerable amount of experience with machinery and equipment.

Interviewee's superior is the only supervisor of personnel in his department.

The working conditions are considered fair. The only complaint was the temperature in the repair shop (a little hot), but the serviceman is used to working in an engine room on a ship and used to the heat.

Interviewee does very little overtime work. When he does he is paid at the rate of time and a half.

Interviewee works with a group of ten men which have equal opportunity to advance to their immediate supervisors position. However, it will take approximately twenty years to become head of the organization.

The specific responsibility of the job is to satisfy customers through maintaining and repairing all gasoline equipped machinery. Interviewee also has to have a valid drivers license because it becomes necessary in his line of work.

The type of equipment he must know how to operate: outboard motors, lawn mowers, tractors, motorcycles, generators, bicycles, and chain saws. Electrical equipment includes: multimeters, coil testers, battery testers, and compression gauges.

The service personnel interviewed enjoys his work very much. Interviewee is well pleased with the fact that, usually, his maximum working time is eight hours, whereby, he is able to spend a considerable amount of time with his family.

Classification: Skilled

Title of person selected:

Auto mechanic manager in business for self

Name of agency at which person is employed:

"multi-occupational," "odd jobs", self-employed

Minimum education required for job:

4 year college degree (preferably in mechanical engineering) is highly desirable. However, service personnel in this type of industry must have a mechanical mind in order to cope with the changes made by the manufacturer without prior notification.

Brief description of job:

Major repair and alteration of any mechanical device.
Advantages: permits individualism, public relations, and high profit margin.
Disadvantages: 24 hour/day occupation

Pay range for job:

Unlimited percentage of take home pay (85% of amount)

Hours per day on job. Any paid vacations? Holidays off with pay?

Up to 20 hours per day. Self-employed, not applicable

Practical experience needed: 4-6 years apprenticeship

Benefits: insurance only

Who does he work for? self employed

Does he supervise others? How many? Yes, three persons

Describe the working conditions. Varies with each job.

The working conditions of this type of service industry are the most unusual due to the fact that the service personnel must have the ability to understand why the American public is so completely disenchanted with their mechanical devices. Repairs and major installations are often installed under very unique situations.

Does he do overtime work? Yes

What are the opportunities for advancement: not applicable

What are the specific responsibilities of the job?

Public relations, maintenance quality; accounting; collection of tools and equipment; maintenance of same. He must also be able to understand the financial difficulties of collecting bills for his service work. The basic problem in servicing all major and minor mechanical devices is the location and obtention of precision parts that meet the needs of the device. Therefore, he must have patience with the parts industry. The most important objective in the service industry is to insure good relationship with the customer. He must also be able to explain his entire repair and major alterations to his customer.

What specific types of equipment must he know how to operate?

Tooling and tooling devices; for electrical, plumbing, and any other specific tools used in the service industry.

Classification: Skilled

Job title: Operator of a Prime Mover (truck driver)

Name of agency at which person is employed:

National Transport company

Minimum education required for job: High School diploma

Brief description of job:

Must be 21 years old. Transport of merchandise in Tampa and neighboring counties. Drives a diesel trailer truck, occasional fork lift.

Benefits:

Advantages:
1. Good pay, in excess of $5.50 hourly wage
2. Many benefits
   a. Three weeks paid vacation after ten years
   b. Health insurance paid
   c. Dental and optometry expenses paid

d. Opportunity for advancement

Disadvantages: Hard work. An applicant must pass a physical examination. The company prefers experienced drivers, but experience isn't required.

Classification: Skilled

Job title: Production personnel (electrician)

Name of agency at which person is employed:

A State Power Corporation

Minimum education required for job: High school diploma

Brief description of job:

Erect power equipment lines(transformers), electrical power lined for homes and industry.

Pay range for job:

From $5500 to 10,000-12,000 depending on supervisory position and years service.

Hours per day on job:

Eight or more five days a week - those two days maybe in middle of week as job is a seven day a week job.

Practical experience needed:

None. They train - Must be 18 years of age to 21 to begin work with this company.

Benefits:

Advantages: Clean work, good pay, family protection (major medical and hospitalization) Good insurance plan. Excellent retirement plan -

Disadvantages: Working all hours on call in case of storms - dangerous high voltage lines, therefore one must know job well or life is in danger.

Who does he work for? The power company is his boss

Does he supervise others? No, not yet as he is only 23.

Working conditions:

Must work in all phases of conditions - rain, sun, etc. (Mud, night-day)

Does he do overtime work?

Yes, he is paid approximately $200 per week 5 days and overtime

What are the opportunities for advancement?

Opportunities are very good. AT least 7-10 years.

What are the specific responsibilities of the job?

Responsibilities are repair of power lines, erect power lines, transformers, or any power source needed for use.

What specific types of equipment must he know how to operate?

Bulldozers for clearing land; hoist on trucks and all mechanics of hydraulic lifter for setting of post-digging of holes; tightening of cables - Some fluid hydraulic systems that they use on rear of trucks - earth diggers and small engines with alternators for emergency equipment.

Classification: Unskilled

Job title: Automobile Sales Personnel

Title of the person interviewed:

New and used car salesman

Name of the company: Local car company

Minimum education required for the job:

Most of the salesmen have a high school education, but it is not absolutely necessary.

Brief description of the job:

Advantages: For the most part interviewee could make a good pay check if his sales were up.

Disadvantages: There seemed to be no help in the sales field. He was given the job

and only a short talk from the boss as to the "hows" of selling an automobile. If no cars are sold within three weeks the job is then given to someone new.

Pay range for the job:

There were seventeen salesmen at the present time at the car company. The quoted salary and commission was $14,000 a year. It was said that there was one salesman in the company that was making $3000 a month. There was also one salesman who has made $3000 in the last five months.

Hours per day on the job:

Nearly ten hours a day, no overtime is earned unless the salesman sells a car. Hours on job are long.

Practical experiences needed for the job:

Interviewee had graduated from a two year business technical school. The knowledge that he had acquired did very little to help in the selling of automobiles. For the most part all of the salesmanship techniques were learned on the job.

Benefits:

The company pays only the most inexpensive type of group coverage that is required by law in the state of Florida. There is no coverage for the salesman's wife and family.

Working conditions:

Very favorable, air-conditioned, pleasant surroundings.

Opportunities for advancement:

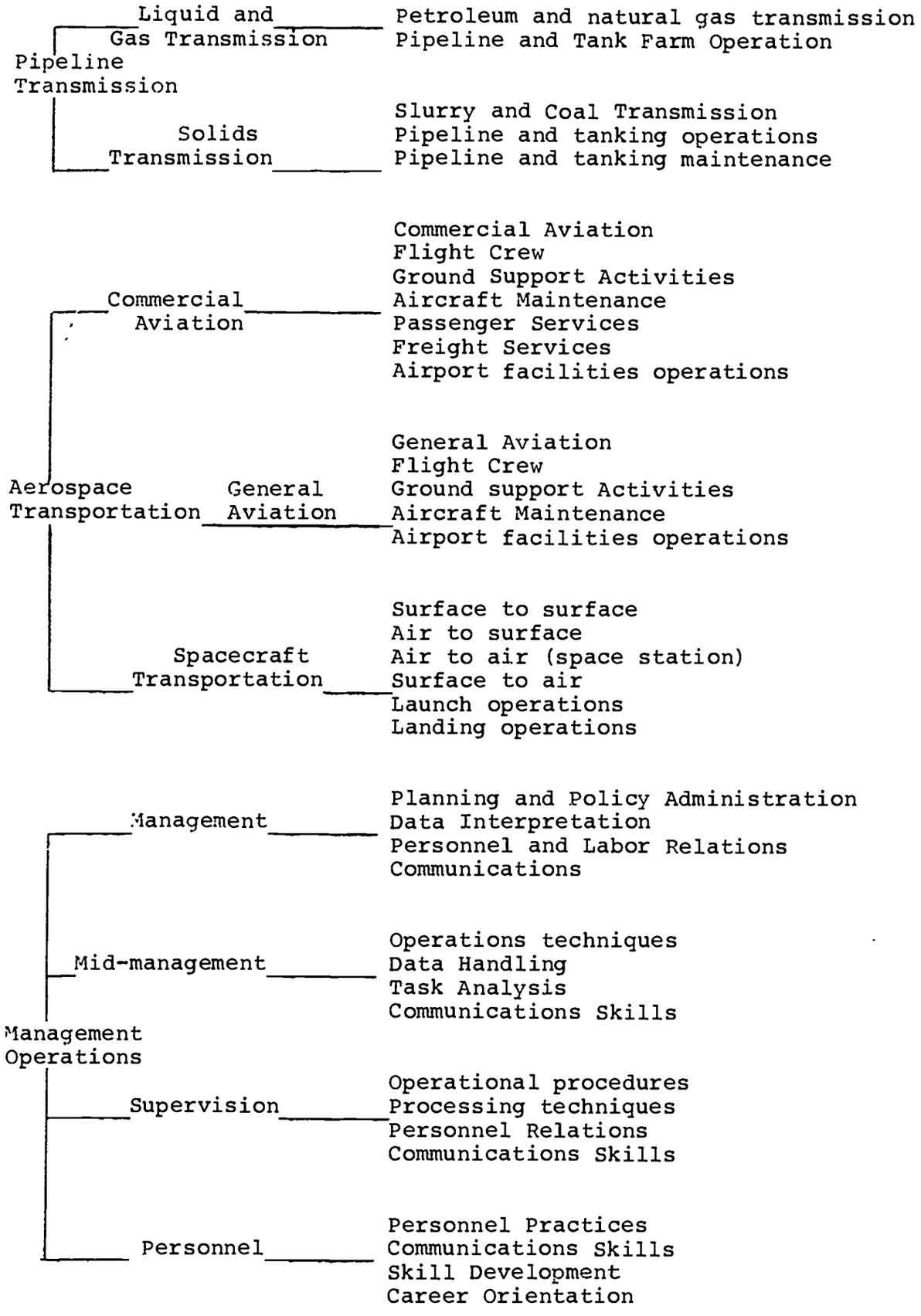
None, interviewee was still in the same position after two years of service.

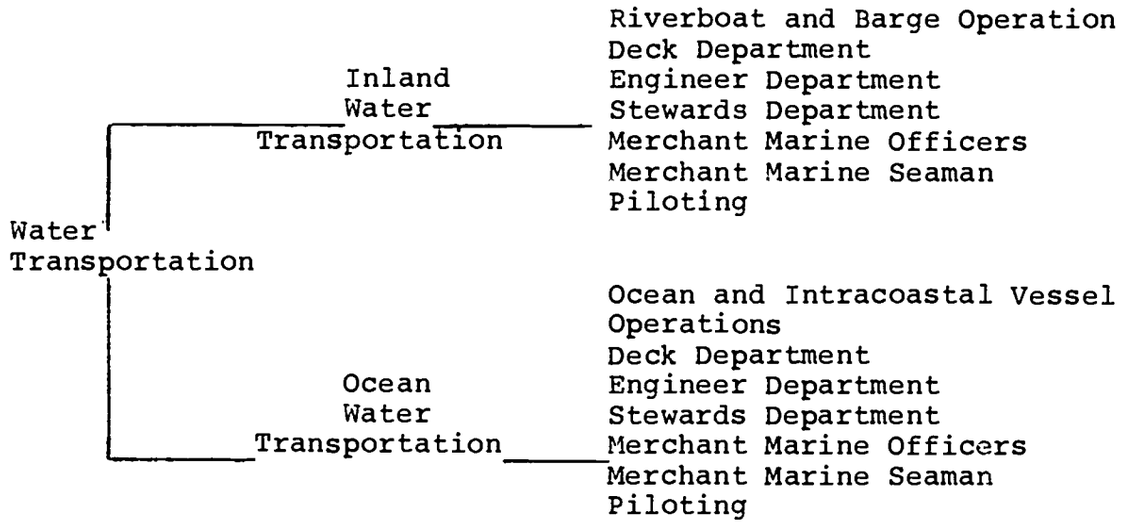
Specific responsibilities of the job:

Honesty, promptness, good public relations, and learning how to get along with people.

OCCUPATIONAL CLUSTERS FOR THE TRANSPORTATION AREA

(Catagory)		(Occupations)
Land Transportation	Local and suburban transit	Vehicle Operation Agents and Clerks Security and Inspection Signals Systems Dispatching systems Equipment Maintenance & Repairs Right-of-way maintenance & Repairs Structures maintenance & Repairs
	Highway Transportation	Vehicle operation Agents and Clerks Security and inspection Freight handlers Estimating Dispatching Systems Equipment maintenance & Repairs Structures maintenance & Repairs
	Rail Transportation	Passenger Service Freight Service Operators Agents and Clerks Security and Inspection Signals Systems Rolling Stock Maintenance repair Way and Structures maintenance & repairs


Pipeline Transmission
Liquid and Gas Transmission
Petroleum and natural gas transmission
Pipeline and Tank Farm Operation
Solids Transmission
Slurry and Coal Transmission
Pipeline and tanking operations
Pipeline and tanking maintenance
Aerospace Transportation
Commercial Aviation
Commercial Aviation
Flight Crew
Ground Support Activities
Aircraft Maintenance
Passenger Services
Freight Services
Airport facilities operations
General Aviation
General Aviation
Flight Crew
Ground support Activities
Aircraft Maintenance
Airport facilities operations
Spacecraft Transportation
Surface to surface
Air to surface
Air to air (space station)
Surface to air
Launch operations
Landing operations
Management Operations
Management
Planning and Policy Administration
Data Interpretation
Personnel and Labor Relations
Communications
Mid-management
Operations techniques
Data Handling
Task Analysis
Communications Skills
Supervision
Operational procedures
Processing techniques
Personnel Relations
Communications Skills
Personnel
Personnel Practices
Communications Skills
Skill Development
Career Orientation


Water Transportation
Inland Water Transportation
Riverboat and Barge Operation
Deck Department
Engineer Department
Stewards Department
Merchant Marine Officers
Merchant Marine Seaman
Piloting
Ocean Water Transportation
Ocean and Intracoastal Vessel Operations
Deck Department
Engineer Department
Stewards Department
Merchant Marine Officers
Merchant Marine Seaman
Piloting

Catagory: Local & Suburban Transit, Land Transportation

Occupation: Vehicle Operation

Title of person selected: Vehicleman (pick up and delivery driver)

Name of Company at which person is employed:

A National Express Company

Minimum education required for job: High School diploma

Brief description of job:

Local pickup and delivery of parcels, using a truck.

Advantages:
(1) Get to know a lot of people in a lot of different businesses; in addition can often buy products at wholesale from these people.
(2) On your own when out in the truck; not being watched by a boss.

Disadvantages:
(1) Heat, cold, and rain have to be put up with.
(2) Not much chance for advancement since jobs are awarded by seniority.
(3) No increase in pay for doing a better job because everyone is doing the same type of job and gets the same pay.

Pay Range for job:

$150 per week for everyone with same job title. Percentage of take-home pay is approximately 70% (9.9% deducted for Railroad Retirement; about 20 % deducted for Federal income tax).

Hours per day on job:

8 hours of working time. Allowed 30 minutes for lunch without pay.

Any paid vacations? Yes. Two weeks after two years. Four weeks after fifteen years Five weeks after twenty-five years.

Holidays off with pay? Yes, most national holidays. If must work, then paid double time-and-a-half.

Practical experiences needed for job. Was it obtained through on-the-job training or apprenticeship? On-the-job

Benefits:

(1) Insurance paid by the company
    (a) Life insurance of $6000.00
    (b) Complete Blue Cross Health insurance for the whole family. Covers doctors, hospitalization, and dental work.
(2) Good retirement benefits based on years worked.

Who does he work for? Express company

Does he supervise any other personnel? No.

Describe the working conditions:

The Company supplies the necessary equipment and materials for the job. Co-workers are helpful and friendly. Employees are unionized.

Does he work overtime? Not often. Does he get paid for it? Yes, at the rate of time-and -half.

What are the opportunities for advancement? How long to be head of the organization?

Not much chance for advancement at the organized labor (union) level. Whenever a new job is to be established it is described in a letter and placed where employees can see it. Those employees who want the job must bid on it before the closing date. This means they must write a letter stating their desire for the job. After the closing date the job is awarded to an employee who has bid on the job and who has the longest seniority (time with the company). Advancement to an administrative, non-union position is somewhat slim. The company seems to hire people directly from the outside for those jobs.

What are the specific responsibilities of the job?

Load truck; check out mechanical condition of truck; secure signatures for those shipments delivered; collect money; write up waybills for shipments picked up; correctly settle money and paperwork at the end of the day.

What specific types of equipment must he know how to operate? Delivery truck; adding machine.

Catagory: Highway Transportation, Land Transportation

Occupation: Security & Inspection

Job title: State Trooper

Name of company/agency by which person is employed?

Department of Highway Safety and Motor Vehicles - state level

Minimum education required: High school diploma

Description of job? Advantages? Disadvantages?

Patrol all records, enforce all laws governing the operation of motor vehicles, pedestrians, etc. Investigate all traffic accidents, assist in apprehension of escaped prisoners, aid disabled motorists, assist other law enforcement agencies when requested to do so.

Steady employment, outdoor work, opportunity to meet the public, paid vacation, more-or-less my own boss, a responsible, exciting job, self-satisfaction of doing a responsible job. Customer is nearly always wrong.

Possibility of transfer, lots of overtime without pay, few weekends off, night work, working in all types of weather, subject to call 24 hours a day.

Pay range? $7370 to $9396 (normal)
$9980 to $10,690 (premium)

Hours? Paid vacations? Holidays?

Nine hour shift - no paid overtime.
Vacation - 8 hours for each month with up to five years experience; 10 hours for each month for anything over five years.
Holidays off if it falls on a regular day off.
Get compensatory time for each holiday worked.

Practical experience needed? Obtained through on-the-job training or through an apprenticeship program?

12 weeks training at the Patrol Academy. Special schools: Breathalyzer, etc.

Benefits?

Paid vacation, uniforms furnished, vehicle furnished, phone bill paid, all equipment furnished.

Who does he work for? State Highway Patrol

Supervise any other personnel? No.

Working conditions? See job description

Overtime work? Paid? Rate? Yes, no pay for overtime work.

Opportunities for advancement?

After 3 years, apply for Homicide Investigator. After 40 hours of schooling, promoted to Trooper II with percent pay increase. After five years, take exam for Corporal rating. Advance to Lieutenant and them to Captain.

Types of equipment you must operate?

Patrol car, camera, breathalyzer, vascar unit.

Catagory: Highway Transportation, Land Transportation

Occupation: Security & Inspection

Title: Assistant Supervisor of Inspection

Company: County-Vehicle Inspection Station

Minimum education required:

High School Diploma plus a satisfactory score on an exam about job requirements.

Description of the job: Inspect vehicles, check equipment, and make minor repairs on equipment.

Advantages: Good working hours, no work to take home

Disadvantages: Exhaust fumes are bad sometimes and customers can be rude.

Pay range: Starting pay per month gross - $401.00
After four years- $494.00 per month

Hours per day: Eight hour day (8 to 5 with one hour for lunch)

Paid Vacation: State holidays
1st year of work - 1/2 day per month
after 1st year - 2 weeks paid vacation

Practical experience needed?

Need a basic understanding of the automobile. Experience is gained through schooling at the Highway Patrol Station plus on the job training.

Benefits:

Regular state retirement, annual sick leave (12 days)
Health insurance paid for by the county plus workman's compensation.

Who is his supervisor? Supervisor of local station.

Does he supervise any other personnel?

All other personnel at the station. How many? Twelve people.

Working conditions:

Hot in the summer, cool in the winter, fumes from exhaust all the time.

Over-time work?

Yes, this usually occurs at the end of each month. Workers work from 8 to 6 the last four days of each month. Pay is figured in the monthly check ahead of time.

Opportunities for advancement:

A regular worker can move up to Assistant Supervisor and then possibly to Supervisor. No set length of time for advancement.

Specific responsibilities of the job:

Make decisions when Superintendent is gone, make up bank deposit and make delivery.

Specific types of equipment the worker must know how to operate:

Light machine, read brake machine, operate jacks in the pit and know where to place the jacks.

Catagory: Local and Suburban Transit

Title: Superintendent of Maintenance

Company: City Transit Company

Minimum education required:

Worker must be experienced. Experience is preferred over formal education.

Description of the job:

Do all mechanical work such as the electrical, engine overhaul, brakes, transmission, and adjusting lights. The amount of actual work done by the Superintendent of Maintenance depends on the size of the operation. The bigger the operation, the more supervising and less work done by the Superintendent.

Advantages: large business - more supervision and not so much actual work. A good worker is always in great demand.

Disadvantages: Responsibility for helpers. If anything goes wrong, the Superintendent must answer, "why"? Records must be maintained on every vehicle. Purchasing records must be kept up to date.

Pay Range: Small business - $5,000 to $7,000/year
Big business - $8,000 to $10,000 /year

Hours per day: 8 to 6 with 1 hour for lunch/45 hour week

Paid vacation: One week/year plus holidays off with pay for Superintendent. Regular mechanics get holidays off without pay.

Practical experience is definitely needed for this job. a worker is trained on the job.

Benefits: Workmans' compensation, unemployment insurance, hospital insurance paid for by the company. No retirement benefits except social security.

Who is his supervisor? Manager of transit company.

Does he supervise any other personnel? Three persons.

Working conditions:

Depends on the size of the operation. A large operation such as the one in Miami would have very nice working conditions. A small business would not provide very good conditions.

Over time work? Yes. Pay is at time and a half.

Opportunities for advancement:

None within the system. A person could move to a bigger company and get more pay.

Specific responsibilities of the job:

Keep up inventory, supervise others, and maintain records of vehicle maintenance.

Specific types of equipment the worker must know how to operate:

Brake drum lathe, tune up equipment, adjust headlights, engine re-build equipment, compression checker, and electrical testing equipment.

Catagory: Local and Suburban Transit, Land Transportation

Occupation: Security and Inspection

Job title: Acting Director of County School Board - Security Officer

Name of Company at which person is employed:

County School Board

Minimum education required for job:

No minimum education at present, but the driver must have chauffeurs liscense, be able to fill out route book, and fill out forms.

Brief description of job. Advantages? Disadvantages?

Drive school bus which transports students. Work rain or shine, straight time pay. After making route in morning, he is off until school is out in the afternoon.

Disadvantages: Work only nine months, low pay scale. The need for an additional job.

Pay Range:

Beginners $166.50; Second step is $176.50; Third step is $186.50 for all part time workers. Only one full time worker and his salary is $345.00 per month. A new salary scale will go into effect on the last of this month (August).

Hours per day on job:

One driver works 8 hours per day and the part time workers work for four hours per day. No paid vacation. No holidays off with pay. One sick day per month. He is hired for 180 days.

Practical experiences needed for job. Was it obtained through on-the-job training apprenticeship?

There is a basic training session for beginners and a general training session for regulars.

Benefits: There are retirement benefits.

Who does he work for? He works for the County School Board.

Does he supervise any other personnel? How many?

Yes, the office workers and gas attendants.

Working conditions: He is to operate the bus under all weather conditions.

Does he do overtime work? Does he get paid for it?

He may be called upon to drive on a field trip which he is paid by the hour.

What are the opportunities for advancement? How long has he been in this position?

There are no opportunities for advancement as a bus driver.

What are the specific responsibilities of the job?

To transport students safely to and from school, see that students get across the streets safely; see that the bus is brought in for inspection and cooperate with principals and teachers.

What are the specific types of equipment he must know how to operate?

1. Operate a fire extinguisher
2. Give first aid if needed.

Other:

The driver is responsible for keeping order and reporting any disturbance on bus to proper authority.

Catagory: Highway Transportation, Land Transportation

Occupation: Freight Handlers

Title of person selected: Foreman

Name of company at which person is employed:

National Express Company

Minimum education required for job: High School Diploma

Brief description of job. Advantages? Disadvantages?

Supervision of unloading of highway trucks and sorting of shipments into delivery routes. See that deliverymen get their shipments loaded into their trucks and that they leave without unnecessary delays. Make sure that the highway trucks leave at the scheduled time. Make some deliveries. An advantage of the job is more pay than a driver, but the pay difference is minimal.

Pay Range: $155.00 per week.

Percentage of take-home pay:

Approximately 70% (9.9% deducted for Railroad Retirement; about 20% deducted for Federal income tax).

Hours per day on job:

8 hours of working time. Allowed 30 minutes for lunch without pay.

Any paid vacations? Yes. Two weeks after two years.
Four weeks after fifteen years.
Five weeks after twenty-five years

Holidays off with pay?

Yes, most national holidays. If must work, then paid double time-and-half.

Practical experience needed for job: Was it obtained through on-the-job training or apprenticeship? On-the-job.

Benefits:

1. Insurance paid by the company.
   a. Life insurance of $6000.00
   b. Complete Blue Cross Health insurance for

the whole family. Covers doctors, hospitalization, and dental work.

2. Good retirement benefits based on years worked.

Who does he work for? Express Company

Does he supervise any other personnel? Yes. How many?

It varies, but about ten.

Describe the working conditions:

The Company supplies the necessary equipment and materials for the job. Co-workers are helpful and friendly. Employees are unionized.

Does he work overtime? Not often. Does he get paid for it? Yes. Rate: Time-and-a-half.

What are the opportunities for advancement? How long to be head of the organization?

Not much chance for advancement at the organized labor (union) level. Whenever a new job is to be established it is described in a letter and placed where employees can see it. Those employees who want the job must bid on it before the closing date. This means they must write a letter stating their desire for the job. After the closing date the job is awarded to an employee who has bid on the job and who has the longest seniority (time with the company). Advancement to an administrative, non-union position is somewhat slim. The company seems to hire people directly from the outside for thos jobs.

What are the specific responsibilities of the job? Refer to Job Description.

What specific types of equipment must he know how to handle?

Delivery truck; highway truck; adding machine.

Catagory: Highway Transportation, Land Transportation

Occupation: Dispatching Systems

Title of person selected: Supervisor of Commercial Transport Line

Name of Company/Agency at which person is employed:

Commercial Transport Line Corporation

Minimum education required for job: None

Brief description of job. Advantages? Disadvantages?

Terminal manager - All phases for the company

Advantages: Pay, vacation with pay, holidays off with pay. Profit sharing, free insurance, free doctor's care and free hospitalization.

Disadvantages: Sometimes must work seven days per week.

Pay Range for job: Percentage of take-home pay?

Pay per hour begins at $2.72 and increases up to $3.25 per hour. There is also incentive pay up to $70.00 per month.

Hours per day on job. Any paid vacation? Holidays off with pay?

The hours per day depend on the run to be made. All holidays off with pay.

Practical experiences needed for job. Was it obtained through on-the-job training apprenticeship?

Yes, there is a training program. You begin as a dockman. Then you are taken on the road with a driver.

Benefits: See Job Description.

Who does he work for? The company owners

Does he supervise any other personnel? How many?

He supervises his office workers, the auto-mechanics, and storage workers. The drivers on the road have seniority and there are sometimes two drivers.

Describe the working conditions.

He works in all kinds of weather

Does he do overtime work? Does he get paid for it?

Yes, and he is paid for all work over 40 hours per week.

What are the opportunities for advancement? How long has he been in this position?

Yes, there is an opportunity to become one of the dock foremen or supervisors.

What are the specific responsibilities of the job?

The man on the road is to deliver his goods with care. Sometimes he must collect for delivery, and take care of his van.

What specific types of equipment must he know how to operate?

A trucker and his van.

Catagory: Rail Transportation, Land Transportation

Occupation: Operators

Job Title: Railroad Engineer (Train Operator)

Name of Company: An Interstate Railroad Company

Minimum Requirements of the Job:

18 years of age, high school graduation, good physical health, five years in training - One starts as a fireman's helper. He then advances by training and testing to a fireman. During this time one can study to become an engineer. He must thoroughly know all the company and government rules, the brake system, the diesel engine and its electrical systems. All of the training material is supplied by the company. In order to become an engineer, one must pass tests and have a minimum of hours running an engine. It may be up to a five year wait for a qualified engineer to receive a job in that capacity.

Brief Description of the job:

Runs engine, follows all railroad and government rules, and makes minor repairs.

Pay Range:

Fireman's helper starts at $700.00 per month; Engineers average between $10,000 and $12,000; Top pay is around $22,000; pay is based on experience and also whether the job is a mileage or local type.

Hours per day on the job:

No more than 12 hours by law; minimum is 8 hours; payed vacation, payed holidays; some weekend and holiday work.

Who does he work for? Train Master and Road Foreman of engines.

Does he supervise any other personnel?

Yes, the fireman and his helper

What are the working conditions? Enclosed cab, heated only

Does he work overtime?

Yes, anything over 8 hours or over a set mileage is paid time and a half or by mileage, whichever is more.

What are the opportunities for advancement? Poor

What specific types of equipment must he know how to operate?

The engine and all of the system connected with it.

Other data:

Will there be a change in the future training methods?

No.

Will there be an increase of jbbs? Yes.

Catagory Rail Transportation, Land Transportation

Occupation: Rolling Stock Maintenance Repair

Job Title: Superintendent of Mechanics Department

Name of Company: Interstate Railroad Company

Minimum Requirements of the job:

18 years of age plus high school diploma and good physical condition.

Brief Job Description:

In charge of inspection and maintenance and repair of all of the freight cars in the Tallahassee area.

Pay Range: $10,000 to $14,000 salary

Hours per day on the job:

Minimum of 8 hours; varies greatly; could be up to 16 or more hours per day

Practical experience needed:

Gained on the job; must first be an apprentice for a mechanic, then a helper, then a mechanic

Who does he work for? The master mechanic in Jacksonville, Florida

Does he supervise anyone? Yes, 24 others

What are the working conditions?

Varies from indoors to out of doors in the open weather.

Does he work overtime? Yes, but he is not paid extra

What are the opportunities for advancement? unpredictable

What are his specific responsibilities?

In charge of all work done on freight cars; in charge of all freight cars in the Tallahassee area; oversees mechanics; orders parts.

What specific types of equipment must he know how to operate?

At present position, none; but, by the time of the on-the-job training, he knows how to operate most of the equipment used by the mechanics.

Other data;

Will there be a change in the future training methods?

No.

Will there be an increase of jobs? No.

Catagory: Rail Transportation, Land Transportation

Occupation: Way & Structures Maintenance & Repairs

Job Title: Foreman

Company: Commercial Railway

Minimum education required: High School Diploma or work experience

Brief Job Description:

The person must be able to read and write. If one likes the outdoors and moving around from place to place it is a good job to have, but there are disadvantages such as weather, hard-work, repairs after reckage, etc.

Pay Range: $859.00 per month for a foreman

Hours per day:

Normal working hours from 7 to 5 daily, five days a week. All paid vacations, and holidays off with pay.

Practical experience needed:

Job is obtained through apprenticeship.

Benefits:

Life insurance, Brotherhood, Union, and Hospital-ization.

Who does he work for? He works for the roadmaster.

Overtime work? None

Opportunity for advancement: Great

Catagory: Commercial Aviation, Aerospace Transportation

Occupation: Freight Services

Job Title: Freight Service

Name of Company: Commercial Airlines

Minimum Education Required: Two years of college

Job Description:

The employee works in all areas of freight hand-ling writing of handbills, and anything to assist the customer in freight handling.

Advantages: Hospitalization benefits, meeting new people, and travel are the main assets.

Disadvantages: Employee must work different shifts from week to week.

Pay Range:

$7,000 to $13,000 a year. Take home all except amount removed for taxes.

Hours per day: 8 hours

Vacation: 3 to 5 weeks, paid.

Holidays: 11 per year with pay.

Practical Experience: None required (on-the-job training)

Benefits: All work on holidays pays overtime

Supervisor: Personnel supervisor. Employee does not supervise others.

Working conditions:

Very good, mostly in air conditioning but some outside work.

Overtime: Some overtime work, always with pay.

Opportunities for advancement: None

Specific Responsibilities: Shared with all other agents.

Specific equipment required to operate:

Tugs, forklifts, handtrucks, adding machines, and typewriters.

Catagory: General Aviation; Aerospace Transportation

Occupation: Flight Crew

Job Title: United States Air Force, Sr. Sqdn. Instructor Pilot

Educational Requirements:

College; graduation from pilot training, Graduate Pilot Instructor Schools

Brief Job Description:

Reviews pilot folders, outlines upgrading training, flies with new pilots to qualify them for duties as KC 135 pilot or copilot. Complete individual folders with training completed and recommends for standardization check.

Pay Range:

$24,000 - $26,000 - less income tax, dependent on size of family.

Hours per day: 8-10

Vacation: 30 days paid; holidays off with pay.

Benefits:

$10,000 paid insurance, for $24.00 a year. Four bedroom home at low cost, all utilities paid; Base Exchange and Commissary privileges; complete medical care for family paid; 20 years retirement at 50% pay.

Who does he work for? United States Air Force

Does he supervise others? Yes, 14 instructor pilots in squadron.

Working Conditions:

8 a.m. - 5 p.m. each day, five days a week. Flights can be either day or night; subject to call 24 hours a day.

Overtime? Some extra work, no extra pay

Opportunities for Advancement:

Can advance to squadron commander, director of operations, Wing Commander through promotion to full Col. - possibly in next 2-3 years.

Specific Responsibilities:

He trains new pilots to fly K-135 air craft in Air Force

Specific Equipment he must operate:

Fly KC-135, operate ground similator, and related equipment, handle all equipment in KC-135 air craft.

Catagory: General Aviation, Aerospace Transportion

Occupation: Ground Support Activities

Job Title: United States Air Force, Superintendent of Avionics Sqdn. (Aircraft maintenance officer)

Educational Requirements:

College; Air Force Electronics School (one year)

Brief Job Description:

Coordinates and supervises operation of all electronic and related systems for KC-135, B-52, C-54, T-29, and all transit aircraft.

Advantages: Satisfaction of doing a large, responsible job. Good opportunity for promotion to Lt. Col.

Disadvantages: Long working hours, day and night, holidays, Saterday and Sunday.

Pay Range: $13,000-$19,000- less income tax dependent on family size.

Hours per day: 12-14 hours a day; 30 days paid vacation; some holidays off.

Experience needed for job: Several years as junior maintenance officer over various sections of squadron.

Benefits:

$10,000 paid insurance, for $24.00 per year; Base Exchange and commissary privilages; complete medical care; 80% medical care for family; 30 days paid vacation a year; 20 years retirement at 50% pay or 30 years at 75% base pay.

Who does he work for? United States Air Force

Does he supervise others?

Yes, 340-360 skilled technicians.

Working Conditions:

Normally 8 a.m. - 5 p.m. - various air craft problems require his presence to make decisions related to systems on air craft. Coordinates 12 different sections in squadron. Has car provided to carry out duties.

Overtime: 4-6 hours,sometimes more; no extra pay.

Opportunities for advancement:

Can advance to squadron commander, rank of Lt. Col.

in 2-4 years time. About seven years to be Director of Maintenance and full Col.

Specific Responsibilities of job:

To keep electronic systems in all air craft operational for 24 hours flight call.

Specific equipment he must know how to operate:

He must know the limitations of his people and equipment available to support the operation of his squadron.

Catagory: General Aviation, Aerospace Transportation

Occupation: Ground Support Activities

Job Title: Maintenance Supervisor

Company: Private Flying Service

Auxiliary Services: Charter Flights, Maintenance & Inspections, Flight Instruction, Crop Dusting.

Job Status: Technical

Job Classification: Mechanical

Pay Scale: $700.00 monthly

Pay Adjustments: Overtime

Job Benefits: Workers Compensation; Social Security

Health Requirements: None

Age Requirements: 18 years old

Working Conditions: Nonstrenuous, Low risk, Outdoors, Shift work.

Job Responsibility: Equipment operated or maintained includes hand power tool, ground support equipment, aircraft ground testing.

Job Security: Employee is part owner, job depends on company success.

Training or Educational Requirements: FAA A&P License

Career Status: Present is stable; Future is uncertain

Miscellaneous information:

Employee in a small highly competitive enterprise, area economics determine business status. Population and economic growth presently declining, outlook not favorable for small business ventures such as this.

Industrial Area: Gas Transmission

Company: Private Company

Auxiliary Services: Sale and Service of gas appliances.

Job Title: Sales Manager

Job Status: Skilled

Job Classification: Administrative

Pay Scale: $650.00 monthly

Pay Adjustments: Raises in grade; Merit promotions; Overtime (1.5)

Job Benefits: Workers Compensation, Social Security, Service paid vacations (3 weeks with 5 years service); Sick Leave, 5 paid holidays.

Health Requirements: None

Age Requirements: None

Working Conditions: Nonstrenuous, low risk, indoors, outdoors, regular hours, 8 hours per day (40 per week).

Job Responsibility: Equipment operated or maintained includes office equipment.

Job Security: Stable business

Training or Educational Requirements: High School and on-the-job training

Career Status: Present (steady growth) Future (continuing expansion).

Miscellaneous Information: Sales Managers receive commission on office contact sales,

plus a 5% commission on off-duty sales. Employees estimated yearly salary is 12,000 dollars.

Catagory: General Aviation, Aerospace Transportation

Occupation: Aircraft Maintenance

Job Title: Aircraft Mechanic

Company: A private aircraft service

Minimum education required: High School or vocation training

Job description: Complete aircraft maintenance

Advantages: Work is cleaner than auto mechanics.

Disadvantages: Works long hours on occasion

Pay Range: $6,500.00 to $12,000.00 per year.

Hours per day: 8 hours

Vacation: 2 weeks per year - paid

Holidays: None

Practical experience: None required but must be trained "on the job" and examined by FAA personnel.

Benefits: Travel and Specialized School training

Supervisor: None (self employed)

Working Conditions: Good, heat in winter, fans in summer; will not work if too hot or too cold.

Overtime: Sometimes, always with pay.

Opportunities for advancement: Many - Raises every year.

Responsibilities: Make aircraft flight ready

Specific equipment required to operate:

Auxillary power units, jeeps, tugs, cranes, and fork lifts.

Catagory: Spacecraft Transportation, Aerospace Transportation

Occupation: Launch Operations

Job Title: Launch Control Officer

Introduction:

This is the individual who actually initiates the launching of a vehicle into space. After all phases of the operation are in readiness and the final countdown has been completed; it is this individual who actually pushes the "FIRE" button.

Future prospects:

Future prospects in this area are very good because of the individuals background in space technology prior to his assuming this position. However, opportunities are somewhat limited to the military areas. A career in the military could be very rewarding since assignment in this area also involves training which would be transferable to many civilian occupations after military retirement.

Qualifications;

Qualifications involve those required for initial entry into the military service in addition to at least a bachelors degree in preferably a science oriented field.

Sex: Limited to male sex.

Height and weight: Not applicable

Legal requirements:

Not applicable after entry into the military service and acceptance into this type of training. Individual would be required to pass a critical security check and psychological evaluation.

Unions: Not applicable

Discrimination: only as to sex

Preparation:

Preparation would consist of that as prescribed by military directives after the selection into this program, however there would be no preparation required

without direction on the part of the individual.

Entrance:

Entrance into this area is as prescribed by governing military directives. There is no entrance through other channels since even civilian sponsored launches are carried out from military facilities by military personnel or at their facilities under direction of the military.

Advancement:

Advancement after this job is confined to supervisory positions in this field and promotions via military channels.

Earnings:

Earnings are prescribed in military pay scales. The average pay and allowances for an individual can be from $12,000 to $21,000 annually depending on ones military grade.

Number of and distribution of workers:

The number and distribution of workers is limited by the number of launch facilities excluding test facilities. It is estimated that based on a missile force of one thousand missiles, it would require approximately 5000 launch officers.

Advantages and disadvantages:

Advantages include excellent pay scales as well as opportunities for self improvement through study while on duty. Advanced degree programs are offered with only minimum residency requirements to be met for obtaining an advanced degree. Free time can be both advantageous as well as disadvantageous since duty hours are around-the-clock necessitating some free time to fall on other than week-ends. Disadvantages include duty in isolated environments and subjection to great mental stresses.

Related occupations: No directly related occupations.

Other renumerations (vacations, merit awards, etc.):

Other renumerations include (in the military) paid vacations of at least 30 days each year; free hospitalization for the entire family including this same benefit after retirement from the military; free dental care including this care after military retirement; opportunity for world-wide travel for the entire

family at government expense including this benefit for one and his spouse on a space available basis for a lifetime; unlimited educational opportunities; retirement after a minimum of twenty years of military service; excellent promotional opportunities.

Catagory: Spacecraft Transportation, Aerospace

Occupation: Space Mission

Job Title: Flight Mission Director

Introduction:

This individual will be THE individual designated and charged with the [illegible] responsibility of making the final decisions for the entire mission or project. His job will require a general knowledge of all propulsion systems associated with terrestial, space and interplanetary flight. He will be required to have a broad knowledge of navigational and photographic systems and also to have a general background of all fuels and related systems. In addition, this individual will be required to have a general knowledgeable background of the specific flight and/or mission.

Future prospects:

Future prospects are excellent and above since this individual will have performed in situations limited to only a select few and will therefore have become proficient to the degree of being proficient enough to assume managerial positions in nearly any related field.

Qualifications (Education, etc.)

Will require at least an advanced degree in an aerospace, engineering or physics field in addition to an above average background in mathmetics and navigation.

Sex: Male (to date, this work had been confined to the male sex because of the experience requirements which heretofore were not available to females)

Height and weight:

Limitations are those as defined for test pilots however may fluctuate based on the nature of the equipment. Note: Height and weight have no bearing on this work in a direct sense however nominees and selectees are more often than not, those with flight backgrounds.

Aptitudes and interests:

A general interest in space and aviation is a definite asset. An interest in astronomy and geography also is a definite asset.

Tools and Equipment: Not applicable.

Legal requirements:

Legal requirements may be encountered only if specific contract involves government contract. Most projects involving government contracts require an individual to be an American citizen and be capable of being subjected to the severest of security checks.

Unions: Not applicable

Discrimination: Non-existent

Preparation:

In addition to points outlined in item 3 above, a succession of positions in the space field including managerial positions is most advantageous.

Entrance:

Entrance into this work is by one of two means: by way of a military career progressing from pilot training to an advanced degree, to test pilot training and finally selection for the space flight program; by way of an advanced degree and direct entry as a civilian into any position in the space program.

Advancement:

Advancement from this area would be as a director of a program encompassing many programs to include future programs, governmental positions in management and directorships of lesser programs planned by companies in experimental fields.

Earnings:

A mission director interviewed who had participated as a mission director of a Project Telstar mission, after twenty three years of experience as an aeronautical engineer and space flight engineer was salaried at $42,500.00 annually excluding unlimited travel expenses. At no time after acquiring an advanced degree did this individual earn less than $22,000.00 annually.

Number of and distribution of workers:

The distribution of workers in this area is very limited due to the limited number of programs. At its peak, it was estimated that there were no more than two hundred workers in this category including back-up personnel.

Advantages and disadvantages:

Although advantages far outweigh the disadvantages, this work also has many undesirable aspects including very unregulated work hours, much unscheduled travel, undesirable living conditions in remote areas when approaching launch times and often deprivations of a normal family life. The advantages include access to data otherwise unavailable which adds to the interest of the job; opportunity for world-wide travel, opportunities for further advancement; opportunities for self-development.

Related Occupations:

Any occupations within the aerospace field data computer field; mathematical sciences field or astronautical fields would involve related occupations.

Other renumerations (vacations, merit awards, etc.)

Among other renumerations in this work are vacations of at least thirty days each year; in some cases, the possibility of ones family being allowed to accompany the individual in world-wide travel; merit awards from the government; promotional monetary awards resulting from press appearances; monetary renumeration for endorsement of products and recognition world-wide resulting from successful accomplishment of missions and/or projects.

Note:

Above data was compiled from an interview on 29 July, 1972 with Mr. Steve Tepp. Mr. Tepp was a graduate of a U.S. Service Academy who later obtained an advanced degree from M.I.T. and was also a graduate of the U.S. Air Force Test Pilot School. After resigning from the Air Force, Mr. Tepp was employed by the Thiokol Company, the Dupont Company and was an engineer with the Comsat Corporation. At present, he is a consultant on space communications with the U.S. government.

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Catagory: Management, Management Operations

Occupation: Planning & Policy Administration

Title or category of person selected:

Acting Director of Transportation

Name of Company/Agency at which person is employed:

County level

Minimum education required for job: High School Diploma

Brief description of job: Advantages? Disadvantages?

Job entails developing school bus routes and time schedules and the hiring and firing of school bus drivers. The advantages of the job are retirement benefits, good working hours, and a car provided. There is so much work involved in this position that it is difficult to find time for a vacation.

Pay range for Job: Percentage of take-home pay?

Total pay: $740 per month
Take home pay: $650 per month

Hours per day on job: Any paid vacations? Holidays off with pay?

Eight hours per day; One day each month paid vacation (accumulated to thirty days) holidays off with pay.

Practical experiences needed for job: Was it obtained through on-the-job training or apprenticeship?

High school education. The job was obtained through on-the-job training in another position and was to be promoted to Acting Director when the job became available.

Benefits:

One day a month paid vacation; One day a month sick leave with pay; school holidays off with pay; car furnished.

Who does he work for? Director of County Maintenance.

Does he supervise any other personnel? How many?

Supervises two secretaries, all the school bus personnel, and the security personnel.

Describe the working conditions: Good

Does he do overtime work? Does he get paid for it?

Yes, when problems arise - no extra pay.

What are the opportunities for advancement? How long to be head of the organization?

Interviewee has advanced as far as he can go with his present educational background.

What are the specific responsibilities of the job?

The biggest responsibility of the job is the hiring of safe and conscientious school bus drivers. He holds the safety of the county's school children in his hands.

What specific types of equipment must he know how to operate?

He must be familiar with the school bus equipment and all phases of the operation.

Title or Category of person selected: Chief Mechanic

Name of Company/Agency at which person is employed:

County Level

Minimum education required for job: High School

Brief description of job: Advantages? Disadvantages?

Supervises the school bus mechanics and other county vehicles. One day a month paid vacation. One day a month sick leave with pay. Paid school holidays. He can use the equipment at work on his own car.

There is no time for a vacation.

Pay Range for Job. Percentage of take-home pay?

Total $700 per month
Take-home pay $600 per month

Hours per day on the job. Any paid vacation? Holidays off with pay?

Eight hours; One day paid vacation per month plus school holidays.

Practical experiences needed for job. Was it obtained through on-the-job training or apprenticeship?

High school education and experience in car repair. On-the-job training.

Benefits:

One day a month paid vacation. One day a month sick leave with pay. Paid school holidays. Equipment available for personal use.

Who does he work for?

Director of County Maintenance

Does he supervise any other personnel? How many?

Supervises the other mechanics.

Describe the working conditions: Good.

Does he do overtime work? Does he get paid for it?

Overtime work without pay.

What are the opportunities for advancement? How long to be head of the organization?

Interviewee has advanced as far as he can go with his present educational background.

What are the specific responsibilities of the job?

The responsibility of the job is to make sure that the school buses and other county owned vehicles are in safe operating condition.

What specific types of equipment must he know how to operate?

He must know how to use all tools, repair, and testing equipment.

Catagory: Management, Management Operations

Occupation: Data Interpretation

Title of person: Civil Engineer I

Name of company/agency where employed:

DOT - State of Florida

Minimum education required:

Graduation from an accredited four-year college or university with major work directly related to the field of engineering to which the position is assigned; or graduation from a standard high school or vocational school and six years of engineering experience directly related to the field of engineering to which the position is assigned.

Brief description of Job:

Serves as chief of party on a location and topographic survey crew. Serves as specialist in the control of bituminous and concrete mixes; supervises inspectors in the testing of soils, aggregates, steel, and bituminous and concrete mixes. Serves as project engineer; performs necessary instrument work; supervises inspectors; and determines that plans and specifications are adhered to by contractors. Performs responsible technical work in bridge and road design and cartographic and photogrammetric drawing; established grade elevation; designs small bridges and culverts; and checks the work of associates and subordinate employees. Conducts origin and destination studies; analyzes traffic data and makes recommendations; prepares simple road and traffic designs. Serves as assistant to the maintenance engineer; assists in the planning of maintenance work; assigns maintenance work to subordinates; provides subordinates with technical assistance with regard to work methods and practices; inspects maintenance work in progress and upon completion; assists in the preparation of maintenance budgets. Assists in the preparing water resource studies and reports. Prepares studies in method analysis and work measurement.

Pay Range? Percentage of take-home pay?

$10,000 - 15,000 per year. Not known.

Hours per day: Vacation? Holidays?

8 hours per day. Employees with less than 5 years service receive 8 hours vacation time per month; those with more than 5 years receive 10 hours per month, accumulative to 240 hours. All national holidays are observed.

Practical experience needed: Was it obtained through on-the-job training or through apprenticeship?

Referred back to description of job.

Advantages? Disadvantages? Benefits?

Insurance provided at good rate; use of credit union; paid holidays; opportunity for advancement; job security; good working hours; sick leave accumulates like vacation time, with no limit on hours accumulated.

Superior: Requested name not be used.

Does he supervise any other personnel? How many?

Yes, three to five, depending on a variety of factors.

Working conditions:

Inside work; air-conditioned; two 15-minute breaks per day, plus one hour for lunch; occasional field trips.

Overtime work? Paid? Rate of overtime pay?

Very rarely; rate is time and half.

Opportunities for advancement: How long to go to the top?

Good - depends directly upon the individual's ability; also depends upon the individual's working habits. Advancement to the top? Cannot be determined.

Specific responsibilities: Referred to job description.

What types of equipment must you know how to operate?

Calculator and surveying equipment (depends on the specific division in which assigned).

If you were advising a high-school student, what specific areas or educational courses would you recommend he/she take in order to establish an adequate background for your type of work?

Math, science, English, physics, and chemistry, and civil engineering courses if available.

Other comments or observations?

The paychecks are as regular as clockwork!

Catagory: Personnel, Management Operations

Occupation: Personnel Practices

Title of person selected: Attorney IV, Department of Transportation

Name of Agency at which person is employed:

DOT, State level

Minimum education required for job: Law degree

Brief description of job. Advantages? Disadvantages?

In Charge of workmen's compensation, admiralty, negligence claims, damage claims, and suits on contracts, by and against the State.
Advantages: reasonable compensation, travel, only one "client"
Didadvantages: ceiling on salary potential, not able to take outside work, bureaucracy

Pay Range for Job. Percentage of take-home pay?

$15,000 - 26,000 (70%)

Hours per day on job. Any paid vacations? Holidays off with pay?

However many are necessary. 8 hours/month paid vacation and 8 hours/month sick leave. All State holidays.

Practical experience needed for job: 4 years legal practice in Florida

Benefits: hospitalization, group auto insurance, credit union.

Who does he work for? legal office of DOT.

Does he supervise any other personnel? How many?

Yes, 3 attorneys and 6 office personnel

Describe the working conditions: Good.

Does he do overtime work? Get paid for it? Yes, but no pay

What are the opportunities for advancement? How long to be head of the organization? His are limited. There are lower ranks - Attorney I,II,III, and IV and General Counsel.

What are the specific responsibilities of the job?

Trial attorney, lawsuits, administratively responsible for workmen's compensation for DOT.

What specific types of equipment must he know how to operate?

All highway and safety equipment; all highway and construction safety standards.

SECTION E

TOOL AND EQUIPMENT LIST
FOR MECHANICAL, ELECTRICAL,
FLUID POWER AND
TRANSPORTATION LABORATORY

(Semester or Year-Long Programs)

SUGGESTED TOOL & EQUIPMENT LIST

FOR 24 STUDENTS (2 STUDENTS PER MOTOR)

(MECHANICAL POWER)

Item No.	No. Req'd	Item	Est. Cost.
1.	1	Set 3/8" Drive Sockets 3/8" to 1" Sockets 3" Extention 6" Extention Speed Handle	
2.	1	Set Combination Wrenches 1/4" to 1 1/4" One Display Board (optional)	
3.	1	1/2" Drive Pull Handle	
4.	1	1/2" Female to 3/8" Male Adapter	
5.	1 ea.	1/2" Sockets 1 1/16", 1 1/18", 1/3/16", 1 1/4"	
6.	12	3/8" Dr. Pull Handles	
7.	12	3/8" Dr. 7/16" Hex. Socket	
8.	12	3/8" Dr. 1/2" Hex. Socket	
9.	12	1/2" X 7/16" Open End Wrench	
10.	12	1/4" X 3/8" Box End Wrench	
11.	12	1/4" Blade 4" Heavy Duty Screwdriver	
12.	6	Spark Plug Socket 3/8" Dr. / Neoprene Insert	
13.	1 set	Allen Wrench	
14.	1	Adjustable Wrench 8"	
15.	1	Adjustable Wrench 12"	
16.	1	Phillips Screwdriver - plastic handle #2 - 3" #3 - 6" #4 - 8" #6 - 8"	

17.	1	Round 6" Blade 5/16" Bit Screw-Driver 4" Blade 1/8" Bit Screw-Driver Offset 1/4" Bit " Square 10" Blade "
18.	1	Hacksaw, Adjustable
19.	4	12 oz. Ball Pein Hammers
20.	3	2 lb. Lead Hammer
21.	3	Replaceable Tip Soft Face Hammer, 8 oz. Heads
22.	1	Slip Joint Plier (Multiple Joint) 10"
23.	3	Combination Plier 6"
24.	3	Needle Nose Plier 6"
25.	1	Diagonal Plier 6"
26.	1	2 1/2 Gal. Safety Can (Gas)
27.	1	2 1/2 Gal. Oil Can
28.	2	Funnels (Aluminum)
29.	3	Bench Oilers-Pint
30.	2	Ignition Feeler Gauges (Wire Type)
31.	2	Ignition Point File
32.	8	Rigid Carbon Scrapers
33.	4	Wire Brushes
34.	2	#12 Xylox Brush (Round)
35.	2	Center Punch 5/16"
36.	1	Center Punch 3/8"
37.	2	Cold Chisel 1/4"
38.	1	Cold Chisel 1/2"
39.	6	Valve Spring Compressor Small Engine 21 in.
40.	6	Piston Ring Compressor 1 3/4 - 3 1/2
41.	24	Pr. Safety Glasses

42.	2	Brodhead-Garrett Small Engine Fly Wheel Puller # SE-10 W (or equal)
43.	1	Zim Ring Expander #203
44.	2	Zim Valve Grinder #301-S
45.	2	Zim Valve Grinder # 311
46.	1	Zim Valve Refacer # 516
47.	1	Zim Gear Puller #601
48.	1	Zim Magnetic Key Inserter, #842
49.	1	Gray Mills Parts Washer #300

Note: A number of small gas engines are usually available free or at low cost through your local lawn mower distributor.

SUGGESTED TOOL & EQUIPMENT LIST

FOR 24 STUDENTS (2 Students Per Work Station)

(Electrical Power)

Item No.	No. Req'd	Items	Est. Cost
1.	5	Volt-Ohm Meter	
2.	2	Condensor-Coil Checker	
3.	12	Electricity Systems (Under Study)	

SUGGESTED TOOL & EQUIPMENT LIST

For 24 Students (2 Students Per Work Station)

(Fluid Power)

Item No.	No. Req'd	Item	Est. Cost
1.	12	Fluid Power Systems (Under Study)	

SUGGESTED TOOL & EQUIPMENT LIST

FOR 24 STUDENTS (2 STUDENTS PER WORK STATION)

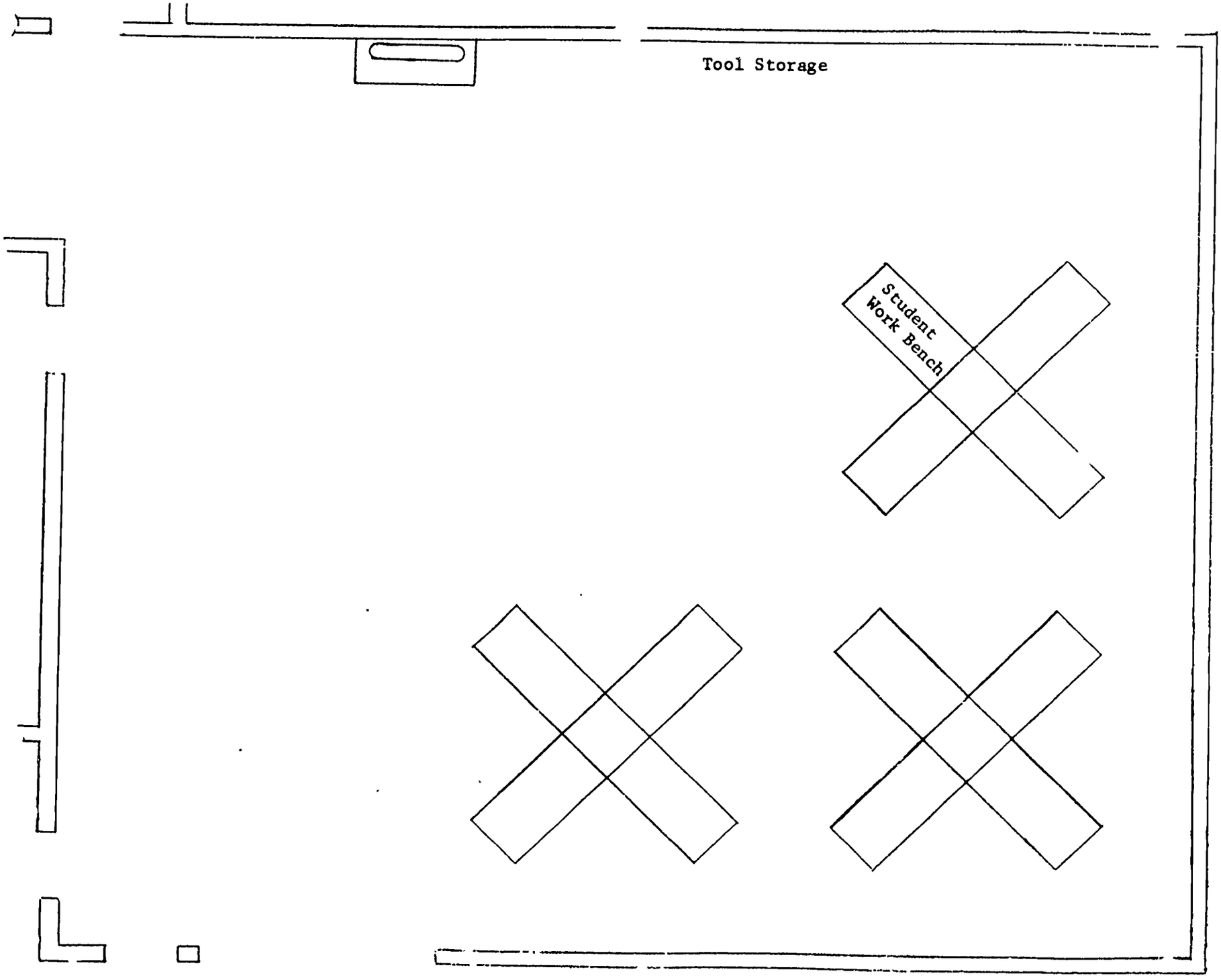
(Transportation Technology)

Item No.	No. Req'd	Item	Est. Cost
		(Under Development)	

SECTION F

SUGGESTED FLOOR PLANS FOR

POWER AND TRANSPORTATION LABORATORY


Tool Storage
Student
Work Bench