TECHNOLOGY EDUCATION

Grades 9-12

PROGRAM/COURSE Energy Applications

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JOB NO.________ PAGE NO. EA1

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~~PHASE: CONCENTRATION~~ ELEMENT: TECHNOLOGY

SYLLABUS: ENERGY APPLICATIONS

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

TOPICS:
I. ENERGY APPLICATIONS OVERVIEW
II. TECHNOLOGY SYSTEMS ENERGY APPLICATIONS

SUGGESTED PREREQUISITE: ENERGY SYSTEMS SYLLABUS
(TECHNOLOGY EDUCATION "FOUNDATION" CURRICULUM)

$$PREPARED BY
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TOTAL TEACHING TIME: 18 weeks

Reprinted 2000

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TOPICS: I - II.

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$SPECIAL NOTE TO TEACHERS

1. Please note that this Energy Applications to Technology Systems is a suggested curriculum.

2. Primary areas to cover are left to the discretion of the teacher, who is most familiar with both the extent of laboratory facilities available to teach this curriculum and the ability levels of the students enrolled in the course.

3. It is the responsibility of the teacher to develop the lesson plans, presentation methods and evaluation tools necessary to utilize this curriculum.

4. The teacher should feel free to adapt these guidelines to fit individual teaching styles and learning styles.

5. A bibliography is provided at the end of each topic. Titled: "Suggested Topical Resources", full bibliographic information for any items mentioned in the topic will be found there.

6. A supplemental packet, titled: "Energy Applications Supplemental Resources" is available for use with the Energy Applications Syllabus. The resource package contains additional resource information and suggested instructional strategies which will assist the teacher in developing individual classroom activities.

   Note: Strategies are keyed to aid the teacher in identification of items appropriate to the Technology Systems Areas:

   C - Communications
   P - Production (manufacturing/construction)
   T - Transportation
   HN - Human needs assessment (engineering/design)

7. SAFETY: All construction and demonstration activities will be in accordance with existing safety procedures for laboratory and shop "hands on" activities. All such activities will be preceded by appropriate operational instruction and applies to all "hands on" activity suggested within this syllabus. It is the teacher's responsibility to address this issue with each class.

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$$CONTENT OUTLINE

TOPIC I. ENERGY APPLICATIONS OVERVIEW

Performance Objective #1:
Energy Applications and the Systems of Technology

A. Systems of technology - identify and define
B. Identify related energy applications to the technology systems

Strategies:

(1 and 2) Communications, production (construction and manufacturing), human needs (design and engineering) and transportation as related to end use energy applications.

Performance Objective #2:
Energy Systems and Energy Applications

A. Energy systems identification
B. Relate the concept of energy systems to technology systems areas

Strategies:

(1) World energy sources
Energy systems technology

TOPIC II. TECHNOLOGY SYSTEMS ENERGY APPLICATIONS

Performance Objective #1:
To demonstrate a knowledge of the evolution of energy from sources to end use application for each of the technology systems (4).

Strategies:

(1) Identify and model an energy converter common to all of the systems of technology.

Performance Objective #2:
To identify, model and performance test energy application devices and procedures in each of the four technology systems areas.

Strategies:

(1) Conduct a human needs assessment and engineering evaluation for a target population, relating energy applications and production. (Example: development of a mass transit shelter)

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(2) Investigation of energy end use and communications methods. (Example: The New York Power Pool - tracing the end use application of energy by the utilities)

(3) Electricity: the invaluable input to the telecommunication industry.

A. Technological time line for electrical communication systems
B. Energy consumption and the telecommunication industry
C. Telecommunication trace of major inventions

(4) Production of an energy conversion device, with emphasis placed upon the application of energy, and the human needs (design) requirement.

A. Product selection
B. Facility evaluation
C. Manufacturing
D. Energy applications/manufacturing processes

(5) Human needs. Developing a plan and a three-dimensional model of a redesigned facility for:

A. Increased energy efficiency
B. Improved physiological comfort levels

Activities include:

A. Energy audit
B. Human needs assessment
C. Floor plan analysis, etc.

(6) Human needs. A home heating problem.

A. Determine heating needs
B. Provide necessary energy sources to meet heating needs

Activities include:

A. Deciding upon home variables
B. Estimate heat loss
C. Using the degree day method
D. Choose energy sources
E. Determine heating costs
F. Survey available renewable energy sources
G. Compare delivered to on-site energy sources
H. Justification statement

(7) Transportation. Investigation of social, economic and technical aspects of transportation with regard to energy applications.

Activities include:

A. Characteristics of a transportation system (technology
B. Analyze transportation vehicles
C. Evaluate power and storage systems in relation to energy systems
D. Construct and performance test selected transporta-

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TOPICS: I-II

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$OVERVIEW OF MODULE

GOALS:

Energy Applications will provide senior high school students with the opportunities to directly test and evaluate the theories and practices of Energy Systems in the day-to-day use by population sectors requiring applications of Technology Systems. Energy Applications investigations will consider areas of Technology Systems, which include: human needs assessment (engineering and design), communications, production, and transportation. Through presentation of basic concepts of the Energy Systems Module, students will be able to focus upon the end use, called Energy Applications, as energy functions as one of the fundamental areas of all technologies.

Through the utilization of direct evaluation techniques, such as performance testing, students will relate energy applications to the areas of technology directly affecting changes and improvements in the lives of members of the global community. Activities and information that the students will be involved with will enable them to:

1. Evaluate energy applications in technology systems (testing, research, etc.).
2. Recognize the importance of energy as a foundation of technology systems.
3. Identify the advantages of varied energy applications to satisfy the needs of technology systems.
4. Appraise the evolution of applications of energy in the operation of technology systems.

DESCRIPTION:

In order for our technological society to function and progress as we know it, it is necessary for the "technology machine" to be "fueled" to continue operation. World energy resources are available for conversion to useable forms in order to provide the power necessary for the technology machine to perform work which will yield the desired outcome for the end user. Conversion of energy sources into useable forms necessary to perform work requires the careful assessment, evaluation and testing of the capabilities of each energy source and conversion device. Proper application of energy resources and systems to the efficient application by energy consuming entities in our society will determine the success or failure of technology systems in meeting physiological, social and economic needs of our civilization.

Energy Applications will allow the consuming sectors of our technological society to closely test and evaluate the performance and efficiency of the applications of energy (end use).

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SKILLS, KNOWLEDGE, BEHAVIORS TO BE DEVELOPED:

Upon completion of the module, the student will be able to:

1. Identify applications of energy end use in technology systems operation and maintenance.
2. Trace energy applications from technology systems end use to energy conversion devices and energy sources.
3. Relate energy applications to design and development, communications, production, and transportation sectors of technology.
4. Illustrate the necessity for proper application of energy sources and conversion devices in technology systems.
5. Conduct basic experiments and evaluations of energy applications in technology systems.
6. Construct, test, and analyze models and energy applications demonstrations.
7. Record and evaluate observations of performance of energy applications in basic technology systems areas.

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TOPIC: I. ENERGY APPLICATIONS OVERVIEW MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Senior high school students, having been given detailed descriptions, illustrative examples, supporting audio-visual materials (movies, slides and graphic displays), will be able to recognize and identify basic energy applications to the operation and maintenance of technology end use systems. Students will demonstrate knowledge through graphic and written analyses of the application of energy to the aforementioned.

In order to do this, the student must be able to:

A. Identify and define the basic systems areas of technology.
B. Relate graphics and illustrative examples to verbal and written observation summaries.
C. Manipulate and identify types of energy applications in technology systems areas.
D. List energy applications utilized in technology systems areas.

TOPIC: I ENERGY APPLICATIONS OVERVIEW
PERFORMANCE OBJECTIVE #1

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$**SUGGESTED INSTRUCTIONAL STRATEGIES**

1. Provide students with detailed descriptions and graphic illustrations of the "systems" areas of technology, which include: communications, production (construction, manufacturing), human needs (design and engineering), and transportation. Present a film to the class which emphasizes the satisfaction of human needs by end use application of energy in the technology systems area.

   Instruct the students to identify the systems areas of technology which satisfy end use human needs applications.

   Student activities:

   a. Outline correlation of energy applications to technology systems.
   b. Poster and model display of energy applications to technology (this could be a class project or "Energy Applications" museum).
   c. Class review of films and presentation materials.

   Materials needed:

   Information sheets, films, library resources, graphic display materials.

   Suggested films:

   Rethinking Tomorrow. US. DOE. Film Library.
   Energy: The American Experience. U.S. DOE.
   Transportation: A Basic Need. Encyclopedia Brittanica.
   Energy in Perspective. Modern Talking Picture Service.

   Resource contacts:

   New York Power Pool
   Local Utility Energy Education Director
   Energy Information Administration. Washington, DC
   New York State Energy Office. Albany, NY

2. Divide the class into four groups, with each group being assigned the responsibility for one of the four technology systems areas (communications, human needs, production and transportation). Each group is to identify and demonstrate one form of end use energy application in the assigned technology systems area.

Example energy applications to systems areas:

Communications: remote site power generation
Devices: batteries, PV cells, wind generators, gasoline generators

Human needs (design and engineering): ergonomics
Devices: vehicles, plant layout, workplace design

Production (construction and manufacturing):
Devices: heat exchangers, cogeneration, heat pumps, building materials

Transportation: mass transit
Devices: aircraft design, propulsion systems, buses, railway systems, highway planning, marine design

Student activities:

a. Construct, demonstrate or illustrate an energy end use application device in assigned technology systems areas.
b. Analysis of drawings, models, and photographs of energy applications.
c. Group discussion and analysis of energy applications devices.

Materials needed:

Basic modeling and graphic presentation tools and supplies, access to assortment of energy applications converters, library resources, drawings, photographs, diagrams and information sheets, worksheets (observation forms).

SAFETY: All construction and demonstration activities will be in accordance with existing safety procedures for laboratory and shop "hands-on" activities. All such activities will be preceded by appropriate operational instruction.

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TOPIC: I. ENERGY APPLICATIONS OVERVIEW MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

2. Senior high school students, having been presented with detailed descriptive information, supported by written definitions, graphic descriptions, and classroom demonstrations, will demonstrate an understanding of the correlation of energy systems to energy applications in technology systems areas. The students will develop graphic presentations for classroom evaluation and consideration.

In order to do this, the student must be able to:

A. Interpret basic definitions and graphic illustrations.
B. Read basic charts and diagrams.
C. Identify the energy systems, listing energy conversion processes and devices and their components (which include location, recovery, transportation, refining, storing, distribution, conversion and use), along with representative devices at each step.
D. Relate energy systems concepts to applications within technology systems areas.
E. Prepare graphic summaries and demonstrations of energy applications to technology systems operation.

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TOPIC: I. ENERGY APPLICATIONS OVERVIEW PERFORMANCE OBJECTIVE #2

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$SUGGESTED INSTRUCTIONAL STRATEGIES

1. Provide students with background materials in the form of transparencies, slides, handouts and reference display models relating to the World's Sources of Energy.

A. Solidify the concept that the basic systems of technology depend upon energy conversions which beginnings stem from the five World Sources of energy, (see chart).

B. Energy Systems Technology: Have students prepare a flow chart which traces the general steps of energy technology from the five world sources to end use, (see chart).

Example #1: Electricity providing light for a building.

Possible steps: Locate coal resource, recover coal resource, store undeveloped coal, develop coal (remove impurities and process to uniform size), store developed coal, on-site electric generation by burning coal, distribution of electricity by transmission lines, end use conversion of electricity to light in a building.

NOTE: Several transportation steps may occur between resource recovery and storage after resource development/refining, as indicated on the flow diagram.

Example #2: Mechanical motion produced by a moving automobile.

Possible steps: Locate petroleum resource, recover crude petroleum, store crude in recovery tanks, transport crude by pipeline to a refinery, refine crude petroleum into products, one of which is gasoline, store gasoline in product tanks, distribute gasoline to gas stations by tank truck, automobile engine converts gasoline into mechanical motion.

NOTE: With a few exceptions, such as natural gas and solar energy, the steps of energy technology chart works quite well in showing students the progression of events for most energy systems. For natural gas, storage is rarely used after recovery and the resource is transported directly to processing where moisture is removed and an odorant is added. Of course, solar energy doesn't have to be stored, refined or developed! It is assumed that the instructor will make his/her students aware of the chart's shortcomings and modify as needed.

C. Students in small groups, using the steps of energy systems technology chart, can research a specific technology system operation from world energy sources to end use.

Example: Technology system: transportation
End use: urban mass transit
Power application: electric motor

Since electricity can be generated by many world sources, the teacher might want the students to choose the source common to the region where the mass transit system is operational for this project (ie. Buffalo's new rapid transit uses electricity generated from a mix of sources, including chemical (fossil-coal) and solar-indirect (hydro)).

D. Another small group project might be to construct a system model from the research, concerning a specific technology system's operation, as with the coal fired/hydro generated electricity for rapid transit.

Materials needed: (A,B,C,D)

World Sources of Energy diagram, Steps of Energy Systems Technology descriptive diagrams, models, supporting audio visual materials, modeling tools/supplies and research resources.

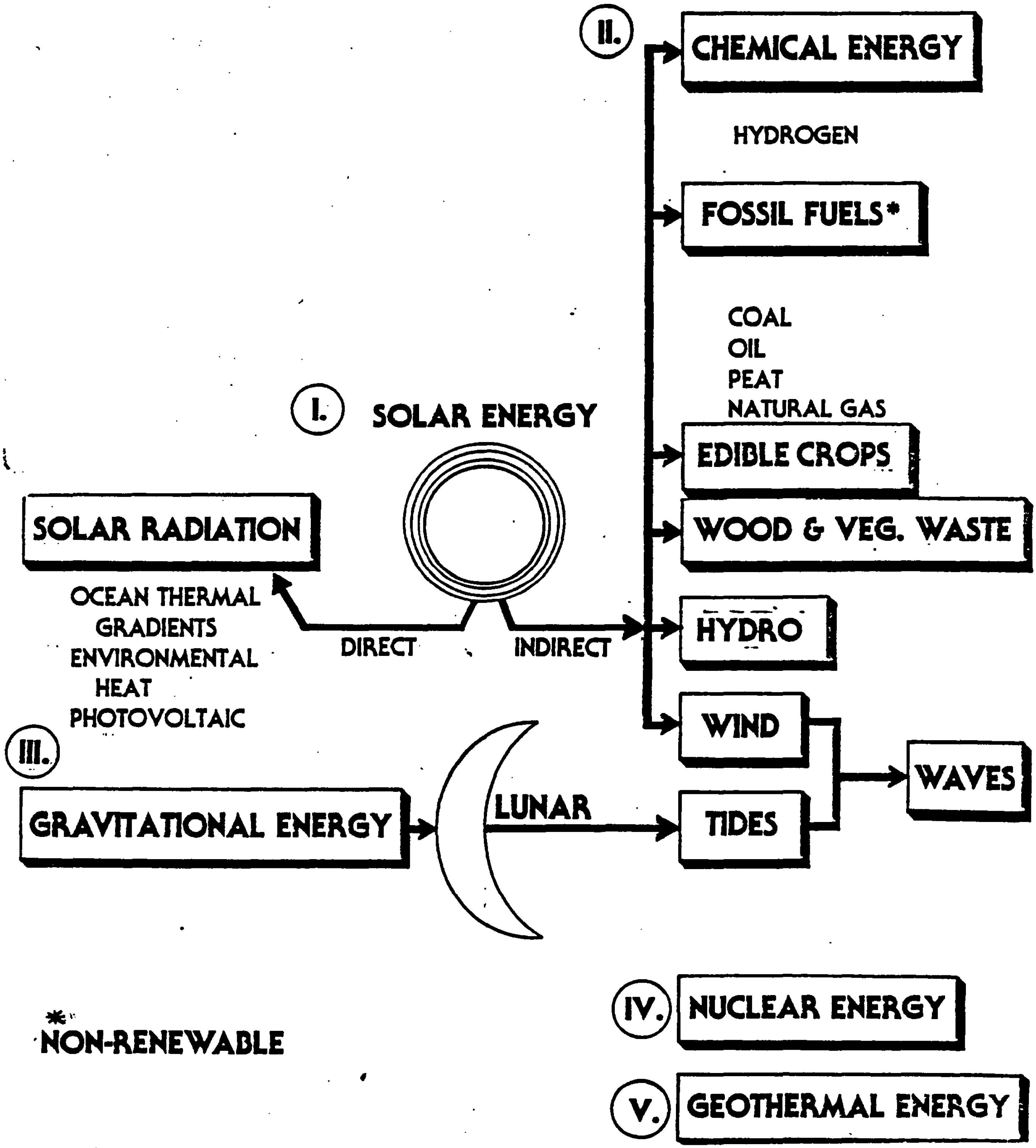
Suggested films:

Clean energy for today and tomorrow
Energy choices: natural gas - bridge to the future
Energy choices: oil and gas - where do we stand?
Gas energy for America
The history of natural gas
Oil: from fossil to flame
Refinery
Coal: bridge to the future
The energy experience
The refinery film

Suggested references:

Energy Systems. NYSED. 1984
Energy Facts. EIA. Washington. 1984.

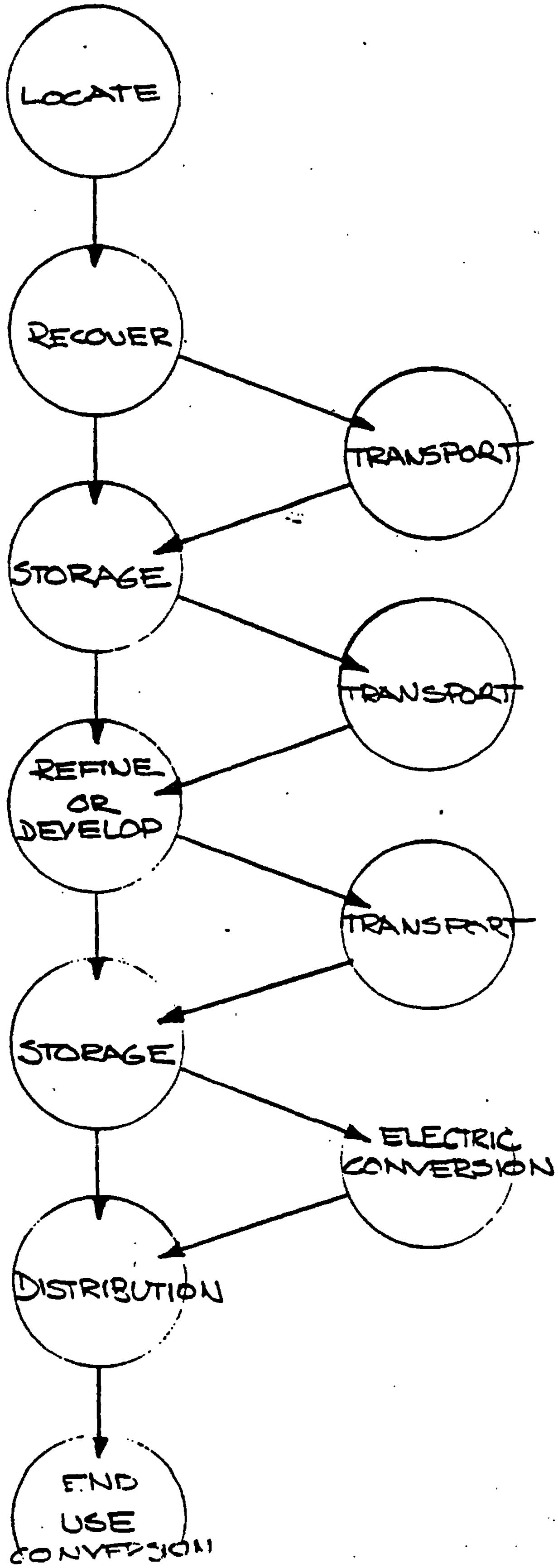
THE WORLD'S SOURCES OF ENERGY



* NON-RENEWABLE

STEPS OF:

ENERGY SYSTEMS TECHNOLOGY



TOPIC: II. TECHNOLOGY SYSTEMS ENERGY APPLICATIONS MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

1. Senior high school students, having studied the evolution of energy systems as a fundamental prerequisite to the operation and maintenance of all technology systems, will demonstrate knowledge of the evolution of energy from sources to end use application for each of the four technology systems. Students will demonstrate knowledge through illustrative graphic presentation and verbal summaries of the evolution of energy applications to technology systems.

   In order to do this, the student must be able to:

   A. Identify and define the four technology systems.
   B. Illustrate examples of energy applications to technology systems through graphic presentation and demonstration methods.
   C. Perform basic evaluation of energy application devices.
   D. Categorize energy applications into appropriate technology systems areas.

TOPIC: II. TECHNOLOGY SYSTEMS ENERGY APPLICATIONS
PERFORMANCE OBJECTIVE #1

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$SUGGESTED INSTRUCTIONAL STRATEGIES

1. After having traced the evolution of energy applications to technology systems end use, students will develop a model of an energy converter or device common to all technology systems end use areas. Divide the class into small groups assigned the responsibility of modeling an energy conversion system common to multiple technology systems areas. Groups will utilize the completed model to assist in tracing the evolution of energy applications from sources to end use in multiple areas of technology systems.

Student activities:

a. Information gathering (letters, research, interviews).
b. Group ideation (brainstorming).
c. Project planning (responsibility delegation).
d. Model construction.
e. Data/information presentation.

Sample models for development:

Steam generators: solar thermal, wood/steam generators, nuclear converters, geothermal generators
Mechanical systems: wind, hydro generators, tidal stations
Photovoltaic generating stations
Vehicles
Structures

Materials needed:

Information sheets, energy evolution flow charts, modeling supplies (wood, adhesives, paints), modeling hand and power tools, resource contacts, graphic display materials.

Resource contacts:

New York State Energy Office (Hotline: 1-800-342-3722)
New York Power Pool
Local Utility Energy Information Director
U.S. Department of Energy
Office of Conservation and Renewable Energy
1000 Independence Ave.
Washington, D.C. 20585

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INSTRUCTIONS (NOTES)

Suggested references:

Energy Systems. NYSED. Division of Occupational Education. Technology Education Curriculum. Albany, NY. September 1984.

Energy Facts. National Energy Information Center. U.S. DOE. Washington, D.C. May 1985.

Kleinbach, M. and Salvagin, C. Energy Technologies and Conversion Systems. Englewood, NJ: Prentice-Hall, 1985.

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TOPIC: II TECHNOLOGY SYSTEMS ENERGY APPLICATIONS

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

2. Senior high school students, having defined and traced the evolution of energy applications to technology systems, will demonstrate an understanding of energy applications through identification and performance testing of energy application devices and procedures in each of the technology systems areas. Students will prepare written, graphic and verbal summaries of observations and conclusions.

In order to do this, the student must be able to:

A. Define and differentiate between the systems areas of technology.
B. Categorize energy applications and procedures required in order for technology systems to function.
C. Conduct performance tests and evaluations of energy applications and procedures.
D. Manipulate basic test apparatus and demonstration models.
E. Record and evaluate performance data.
F. Prepare graphic presentations of energy applications related to technology systems functions.

TOPIC: II TECHNOLOGY SYSTEMS ENERGY APPLICATION
PERFORMANCE OBJECTIVE #2

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$SUGGESTED INSTRUCTIONAL STRATEGIES

1. TECHNOLOGY SYSTEMS APPLICATIONS AREAS:

   A. PRODUCTION - construction
   B. HUMAN NEEDS - design/engineering

Provide students with a detailed description of the relationship of energy applications to human needs, with special emphasis being placed on ergonomic design and assessment of physiological requirements for a given set of climatic conditions. Students, in small groups will conduct a complete human needs assessment and engineering evaluation for a target population and relate energy applications to both human needs (design/engineering) and production (construction).

Sample strategy:

Description:

Assign student teams the responsibility of developing a shelter for clients of a mass transit system in rural or suburban areas. Teams are to design and engineer the shelter for a specific climate, utilizing the application of energy conscious design and construction methods to satisfy the physiological needs of the target population. The shelter is designed to meet the total climatic conditions for a given latitude and heating degree day (HDD) range.

Climate: (example)
Saratoga County, NY (approximately 42 degrees NL to 43.5 degrees NL)
Annual HDD range: 6000-8000 HDD
Weather/climate: seasonal (cold winters/hot summers)

Population: design target group
Senior citizens and young school children
Structure population: capacity range 5-10 clients

Student activities:

a. Human needs assessment (ideation, brainstorming, interviews).
b. Preliminary design analysis (sketches, notes).
c. Site analysis (plot plan).
d. Structure configuration analysis (floor plan).
e. Concept models (cardboard mockups).
f. Building heat load calculations.

g. Site and shelter detailed model.
h. Construction cost analysis.
i. Graphic and verbal summary.

Materials needed:

Drafting and graphic display materials, library resources, hand and power modeling tools, local weatherization information contacts, model construction supplies.

Suggested resources:

Architectural and Graphic Standards. Ramsey and Sleeper. AIA.
ASHRAE Systems Handbook: Local Weatherization.
Local unit of the National Weather Service.
The Passive Solar Energy Book. Ed Mazria.
The Passive Solar Construction Handbook. Steven Winter Assoc.
Fundamentals of Energy Engineering. Albert Thumann.
Weather and Climate. Raymond C. Falconer ASRC.Albany.

2. TECHNOLOGY SYSTEMS APPLICATIONS AREA:

COMMUNICATION

Provide the class with the opportunity to either visit the local utility energy information center or invite a representative from the local utility to the class to investigate the correlation between enery end use and communication methods utilized in order to deliver energy services and information to the consumer.

Students will be required to record observations relating to the application of communications techniques and methods in the operation of energy supplying industries. The students also have the responsibility of tracing end use application of energy by the utilities in order to "sell" energy as an end product through diverse communications methods.

Suggested contacts:

Director of Educational Services
New York Power Pool
3890 Carman Road
Schenectady, NY 12303

New York State Energy Office
Two Rockefeller Plaza
Albany, NY 12233

Local utility energy information director

Example visitation sites:

Power Vista at Niagara Falls
Robert Moses Power Plant at Massina
Nine Mile Two Energy Information Center at Oswego
Blenheim-Gilboa Power Plant at Grand Gorge
Indian Point Energy Information Center at Buchanan
New York Power Pool Headquarters at Schenectady (Guilderland)

Materials needed:

Notebooks, 35mm camera (slide film), access to school mailing facility, resource contacts, graphic display materials and supplies.

3. TECHNOLOGY SYSTEMS APPLICATIONS AREA:

COMMUNICATION

Introduction: During the last 25 years, people have developed new channels of communication between themselves, databanks, and worldwide computer networks. Hand held computers, microprocessor technology, fiber optics and thin film transistors provide clues on what is yet to come.

As our ability to communicate has exploded, so has our use of that flexible energy form...electricity. Electricity, of course, is an "intermediate" form of energy that is not considered a source or an end use. Electricity, in its useable form is generated from a world energy source such as chemical, nuclear, solar, gravitational, or geothermal. In short, electricity is our most convenient energy form, which happens to be an invaluable input to telecommunication systems.

A. Have students formulate a technological time line for electrical communications systems which should include:

time frame
contribution or invention
contributor or inventor and nationality
brief statement concerning the importance of energy

Example: Ancient Era
Before 400 B.C.
Discovery of magnetic attraction of Magnetite
Magnes (Asia Minor)

Later it was discovered that magentism and electric current were closely related, and would have a profound effect on the development of the modern world.

Example: Modern Era

1799

Produced electricity from a chemical battery

Volta (Italian)

A source of electricity other than static electricity which would eventually provide the modern world with a portable, compact, lightweight power supply.

B. Have the students use various resources to determine the energy consumption attributed to the telecommunication industry in terms of quadrillion BTU (QBTU) and/or percent of our total national consumption (annually).

In broad terms, electricity provides less than 10% of our total end use energy for all activities other than heating, cooling and mechanical work. Besides telecommunications, this figure also includes such things as: electrochemistry, refining (arc furnace), electric welding, etc.

C. Have students choose a modern telecommunications system and trace its technological heritage to major inventions which insured its success.

Student activities:

1. Specific time-line trace (written)
2. Illustrative block diagrams
3. Pictorial illustrations
4. Models

Sample systems for development - models:

radio
television
radar
radio astronomy
microwave transmission
masers
lasers
space communications
communication satellites

Materials needed:

Information sheets, art and modeling supplies, modeling hand and power tools, resource contacts, graphic display materials.

Suggested resource contacts:

IBM
Texas Instruments

Time Computer, Inc.
Honeywell, Inc.
General Electric
Westinghouse
RCA
Smithsonian Institution

<u>Suggested references:</u>

<u>Connections.</u> James Burke.
<u>Energy Facts.</u> EIA.
<u>Getting the Message</u>. Barry J. DuVall, et.al.

<u>Suggested video:</u>

<u>Connections.</u> James Burke. PBS Video, WGBH - Boston.
(a multiple segment presentation)

4. <u>TECHNOLOGY SYSTEMS APPLICATIONS AREA:</u>

A. <u>PRODUCTION:</u> manufacturing
B. <u>HUMAN NEEDS</u>: design/engineering

Present to the class a variety of simple products representing energy end use applications which can be manufactured in a laboratory (shop) setting. Students are to "engineer" an energy conversion device that can be produced by the class with emphasis placed upon the application of energy to the design and production of the end product. Emphasis is also to be focused upon the relationship of energy applications to the function of the workers in the workplace involved in the manufacture of the end product.

<u>Student activities:</u>

A. Product selection and design
B. Facility evaluation and design
   - plant layout: ergonomics, energy conservation
   - materials flow
   - facilities systems operation: energy audit and control (heat, lights, machines, tools, waste heat recovery)
C. Manufacturing (assembly line)
   - quality control/product testing
   - distribution/packaging/marketing
D. Correlation chart of energy applications to manufacturing processes

Example energy applications products:

- Solar air collectors
- Photovoltaic fan kits
- PV radio kits
- Concentrating solar heaters
- Window insulation kits
- Heat exchangers
- Thermal curtains
- Window box greenhouse

Materials needed:

Drafting and graphic layout supplies, measuring tapes, shop facility (general layout for wood, metals, etc.), assorted construction supplies (dictated by product), thermometers and product monitoring devices, library resources, worksheets (task and scheduling sheets), notebooks.

Sample activity (product) references:

- John Barling's Solar Fun Book.
- 20 Simple Solar Projects. Rodale Press.
- Home Mechanix Magazine
- Popular Science Magazine
- New Shelter Magazine

5. TECHNOLOGY SYSTEMS APPLICATIONS AREA:

HUMAN NEEDS: design/engineering

Provide students with a detailed description of existing shop or laboratory facilities. Assign the class the responsibility of developing a plan and constructing a three-dimensional model of a redesigned facility employing principles appropriate to increased energy efficiency and improved physiological comfort levels. No design restrictions should be applied in order to achieve the "total" energy conscious redesign of the facility.

Student activities:

A. Energy audit (conservation analysis)
B. Human needs assessment (population identification)
C. Traffic flow/facility utilization schedule
D. Floor plan analysis
E. Ideation (sketching, concept mockups)
F. System monitoring/measurement
G. Model development and construction

Materials needed:

Thermometers, light meters (metering devices), drafting and graphic supplies, library resources, model construction supplies, model construction hand and power tools.

Suggested references:

Fundamentals of Energy Engineering. A. Thumann.
Handbook of Energy Audits. A. Thumann.
The Passive Solar Energy Book. E. Mazria.
Saving More With Energy Conservation. US. DOE.

6. TECHNOLOGY SYSTEMS APPLICATIONS AREA:

HUMAN NEEDS: design/engineering

Provide students with a home heating problem for a specific site in New York state. They will have the opportunity to solve this problem in many different ways, depending upon the particular set of variables which they choose.

The general method of solving this problem is to:

1. Determine the home heating needs, and
2. Provide the necessary energy sources to meet the heating need.

Specifically, the following requirements must be adhered to:

A. Class is split into groups of 2-3 people
B. Goal of the group is: to utilize a mix of available energy sources which will heat the proposed home.

Some considerations to be aware of are:

monthly fuel costs
heating system costs (captial investment)
system efficiency
system's useable lifespan
maintenance requirements for the proposed heating system

The house is home for four people, a dog and a cat. The sample house to be considered here is a ranch style with 2025 square feet of floor space, on the main floor. It has a full basement. It's dimensions are 45 feet by 45 feet. The house is square. It has 8 foot high ceilings, 15 windows (150 sq.ft.-total) and 3 doors (60 sq.ft.-total). The variables for this house are as follows:

1. Amount of wall insulation.
2. Amount of ceiling insulation.
3. Type of insulation.

4. Type of window (single pane, double...etc)
5. Window/door location on house.
6. Methods of limiting infiltration losses.

I. The following procedures are followed by each group.
<u>Each step MUST be addressed</u>:

1. Decide upon variables 1-6 from the above home.
   A. Calculate the cost of each. (See references).
2. <u>Estimate the heat loss</u> for your proposed house based upon a <u>worst case temperature</u> that may be encountered (see Suggested references - Keys).
3. Convert home design temperature requirements into more useful units (BTU/DAY) using the <u>degree day method (DD)</u>. Use <u>DD tables</u> (see references) to calculate the heating requirements for each month of the heating season, for the specific location of the house.
4. <u>How much energy is required per day to meet this heating need?</u>
   <u>NOTE</u>: The following sample problem illustrates the method used to answer the above question:

   a. If the house heat loss has been calculated to be 30,060 BTU/hr, at a worst case design temperature of -10 degrees F.
   b. In 24 hours at -10 degrees F, the house will require 721,400 BTU's (30,060 X 24) to keep it at 70 degrees F.
   c. Between the base temperature 65 degrees F (the <u>degree days system</u> says that no heat is required if the outside temperature is 65 degrees F or above, to maintain an inside temperature of 70 degrees F) and -10 degrees F, there are <u>75DD</u>. Dividing the 24 hour requirement of 721,400 BTU by 75, we get a requirement of <u>9,620 BTU for each degree day</u>.
      <u>*This is known as a 9620 BTU/DD house</u>. <u>This also means that if the outside temperature is 64 degrees F, it would require 9620 BTU to heat the house for 24 hours.</u>
   d. Using <u>degree day tables</u> to calculate heating requirements:
      1. In Buffalo, the number of degree days in January is: 1256. We now multiply the size of the house expressed in BTU/DD and find the average heating requirements.
      2. Using the 9620 BTU/DD house, we multiply 9620 times 1256 = 12,082,720 BTU required to heat the house for the entire month of January. To find the average requirements (daily), divide by 31, <u>obtaining 390,000 BTU/day</u>. Similar calculations can be performed for each of the winter months.

5. From the above information, how large a conventional furnace would be required to meet the heating need?

   Example: If 390,000 BTU/day is required to maintain 70 degrees F inside air temperature, a furnace with 100,000 BTU/hr. capacity would operate about 20% of the time (average). 100,000 BTU/hr X 20% (or .2) of the time, at 82% (.82) efficiency = 100,000 X .2 X .82 = 16,400 BTU/hr X 24 hours = 393,600 BTU/day.

6. List some of the variables which affect the performace of any heating system.

   Examples:
   - solar insolation
   - wind
   - temperature maintained on inside of the house
   - energy consciousness of the family
   - living habits taken into account

7. From the available energy sources, choose a mix which might meet the house heating needs from the following groups:

   a. Delivered public services:
      - natural gas
      - electricity
      - home furnace oil
      - propane
      - fire wood

   b. On site energy resources:
      - fire wood
      - hydro (water power)
      - solar
      - wind
      - biomass

8. Heating costs will be determined from the following rates on delivered public services:

   - natural gas - cost per therm
   - electricity - cost per KWH
   - home furnace oil - cost per gallon
   - propane - cost per pound
   - firewood - cost per face cord

   NOTE: After determining the above costs, find the BTU's for each of the units (ie. BTU/therm).

9. Heating costs for on-site resources involve other considerations, including:

   a. The extent of the resource (wood, hydro, solar, wind and biomass). This usually requires a survey (ie. monitoring the wind for a period of months to determine average monthly wind speeds for your site).

b. The size of the system needed to provide needed energy.
c. The type of energy delivered (eletricity, heat or mechanical) and the estimated efficiency.
d. The capital investment. Although the energy is "free" the machinery isn't!
e. The projected life of the system.
f. The estimated payback period on the investment.

NOTE: See References section for recommended resources for renewable energies.

10. Compare the delivered energies which are not free and with rates which are not guaranteed, to the on-site renewable energy resources, that are free, but have very expensive equipment costs. (ie. A natural gas furnace might cost $1,500, on the average. A comparable solar space heating unit might cost $15,000!)

11. Make a justification statement utilizing all of the collected data:

insulation costs
window and door types and placement
heat loss calculations
degree day determinations
heat requirements
other variables that affect a heating system
the energy mix you choose
energy costs vs equipment costs
conclusions

Materials needed:

Reference materials, calculator, worksheets.

Suggested references:

Harnessing the Sun. J. Keys.
Alternative Sources of Energy magazine
Solar Age magazine
Mother Earth News magazine
Home Energy Digest/Wood Burning Quarterly
The Wood Energy Institute.
Alternative Energy Assn. of America
American Gas Assn.
American Petroleum Institute
Biomass Energy Institute
The Residential Energy Manual. U.S. DOE
Introduction to Life Cycle Costing. R. Brown et.al.
Other Homes and Garbage. Leckie, J.
NYS Energy Master Plan. NYS Energy Office
New York Electric & Gas Corp.
NYS Power Authority

NY Power Pool
Niagara Mohawk Power Corp.
Renewable Fuels Assn.

Suggested films:

The Solar Generation
The Sunbuilders
Tapping the Source
Home Heating with Wood
Hottest Show on Earth
* ALL from NYS Electric & Gas Corp.

Energy From Day Star

All from Modern Talking Picture Service

Build Your Own Greenhouse - Solar Style - $50
A Building in the Sun - $35
Building the Brookhaven House - $45
Design with the Sun - $55
How to Keep the Heat in Your House - $50
Kilowatts From Cowpies - $45
Opening Your Home to Solar Energy - $50
The Solar Frontier - $45
Tree Power - $50
Water Power - $50
Wood Heat - $50
All rental films from Bullfrog Films

7. TECHNOLOGY SYSTEMS APPLICATIONS AREA:

TRANSPORTATION

A. Have students research the role of transportation from the social and economic viewpoint, thus establishing it as a viable user of energy within our society.

Example #1: Economic:
1. a system
2. a service
3. an industry
4. an employer
5. construction activity
6. energy consuming activity
7. an economic input to industry

Example #2: Social:
1. affects the quality of life
2. the automobile culture
3. provision of transportation services
4. noise and pollution
5. legilation for unwanted by-products of transpor-

tation.

Example #3: Energy Consumption:

1. transportation's percentage of total - 26%
2. actual amount consumed annually
3. indirect amount of energy consumed (industrial sector)

B. Have students investigate the systems of transportation, by selecting a known vehicle and describing it in terms of relevant technical characteristics;

These characteristics are:

1. Degrees of freedom - (1st, 2nd or 3rd)

   1st - systems confined to a track
   2nd - systems confined to a surface
   3rd - systems able to move in three directions

2. Autonomy of control - (1st, 2nd or 3rd)

   1st - individually operated
   2nd - chauffered public transport
   3rd - automatic system

3. Support and suspension (active and passive)

   active - downward mass flow (jet engine)
   downward mass flow (propellers)
   lift (aero or hydrodynamic)
   air cushion (by forward motion)
   air cushion (air compressors)
   electromagnetic repulsion

   passive - mass displacement (balloon/boat)
   wheel and axle, legs, skid

4. Propulsion

   backward mass flow (jet)
   backward mass flow (propeller)
   push against earth (wheel, leg)
   negative jet or ram (sail, catapult)
   moving roller/belt
   chain or tensional cable
   electromagnetic field (linear induction motor)
   gravity

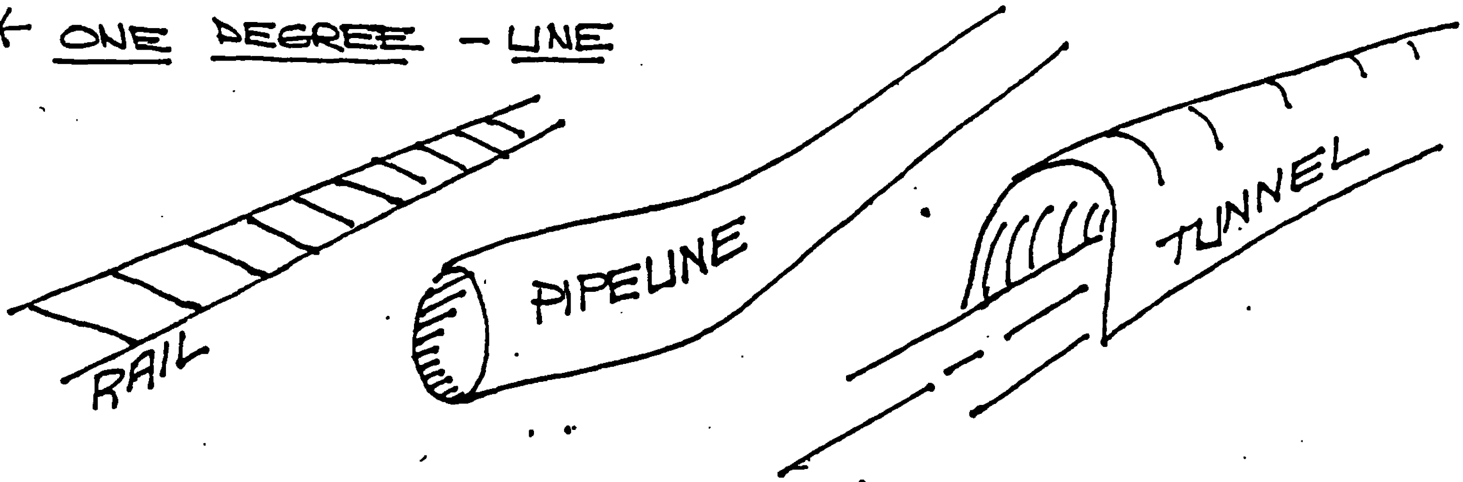
5. Power and storage and energy conversion - over 300 possible combinations (see power and storage chart).

TRANSPORTATION SYSTEMS

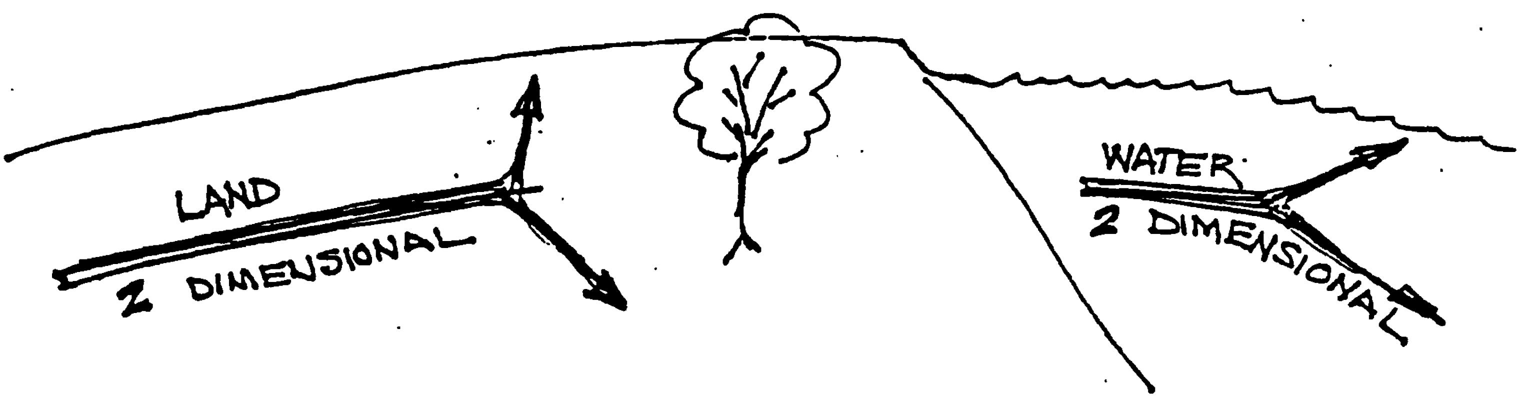
Pg # 1
EA-32

DEGREES OF FREEDOM

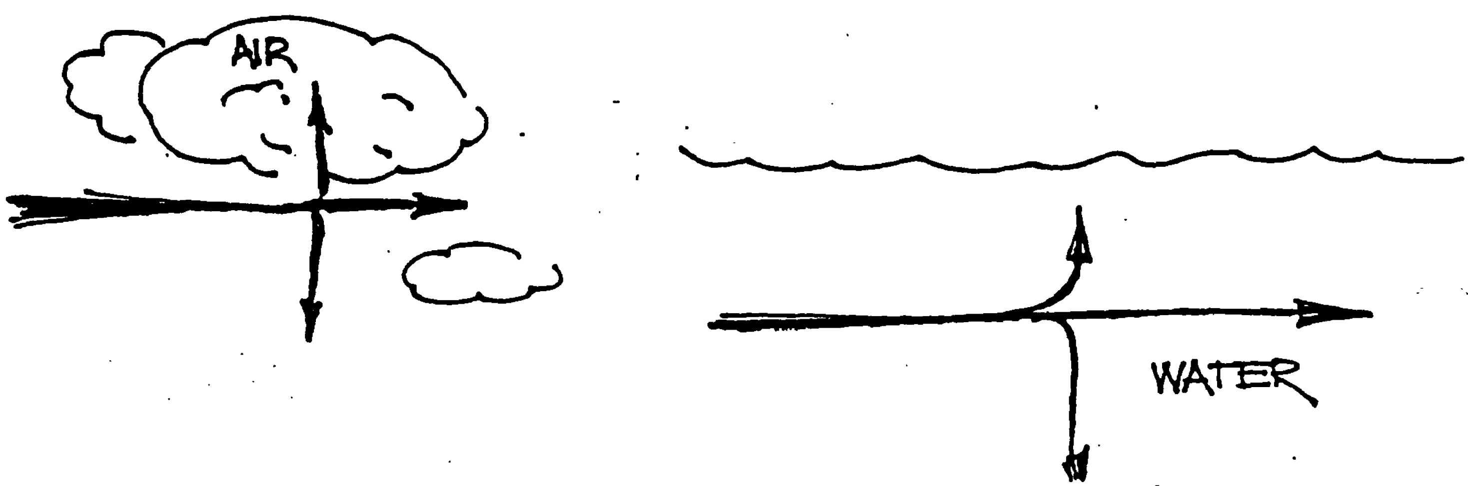
* ONE DEGREE - LINE



* TWO DEGREE - SURFACE



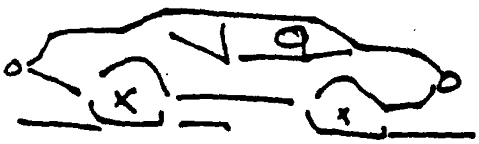
* THREE DEGREE - 3 DIMENSIONS



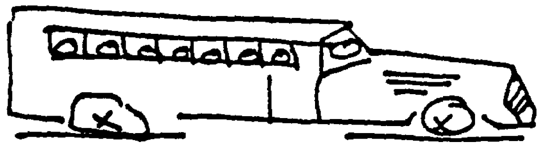
TRANSPORTATION
SYSTEMS

CONTROL

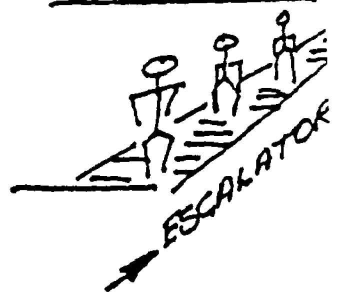
#1 INDIVIDUAL



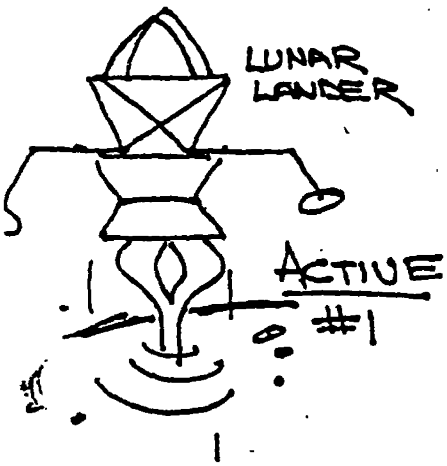
#2 CHAUFFEURED



#3 AUTOMATIC

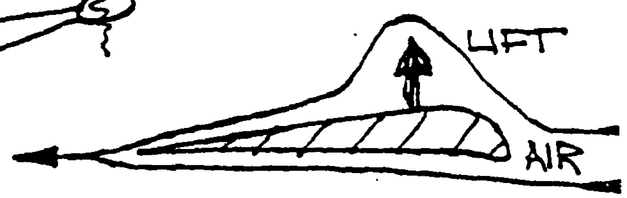


SUPPORT AND SUSPENSION

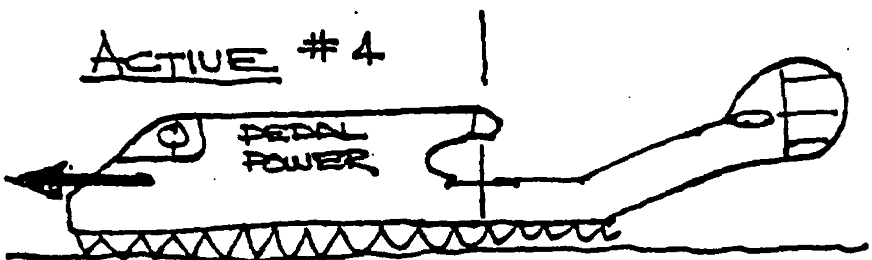


ACTIVE #2

ACTIVE #3



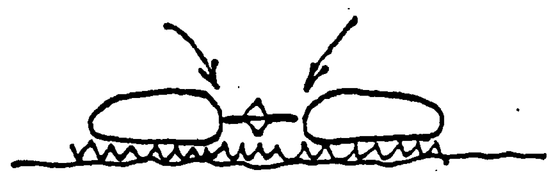
ACTIVE #4



AIR CUSHION

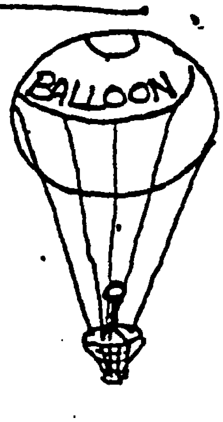
ACTIVE #5

COMPRESSOR

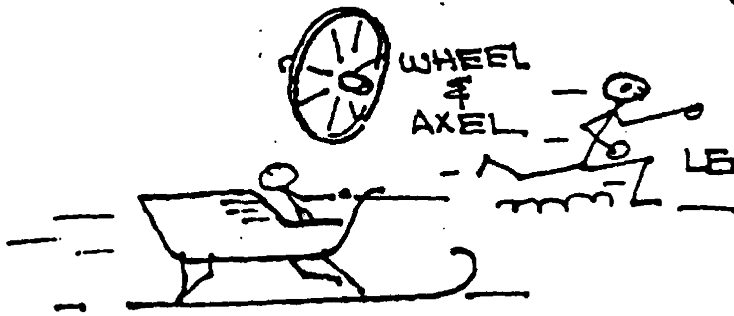


AIR CUSHION

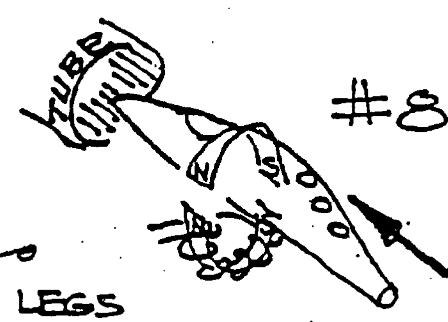
PASSIVE #6



PASSIVE #7



#8

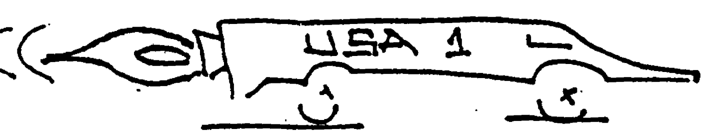


ELECTRO
MAGNETI
REPULSIO

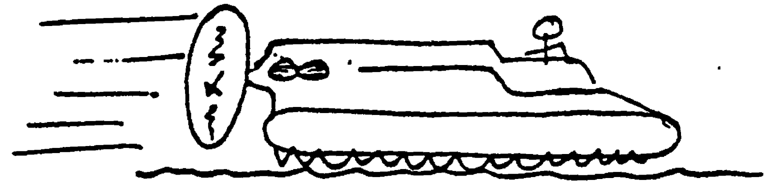
TRANSPORTATIO
SYSTEMS Pg #3
EA

Propulscoin

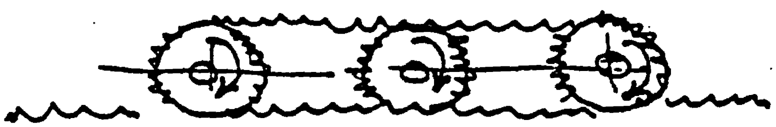
#1 BACKWARD MASS FLOW
JET



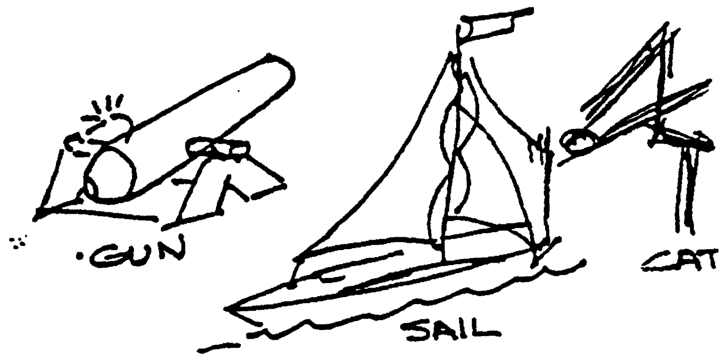
#2 BACKWARD MASS FLOW
PROPELLER



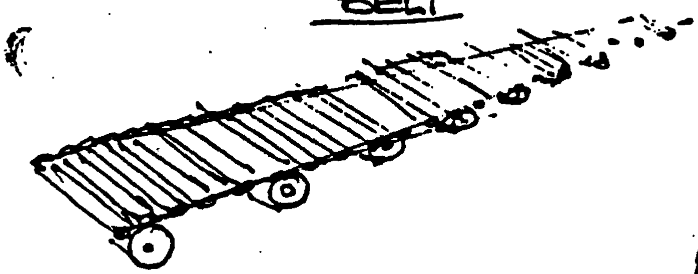
#3 PUSH AGAINST EARTH



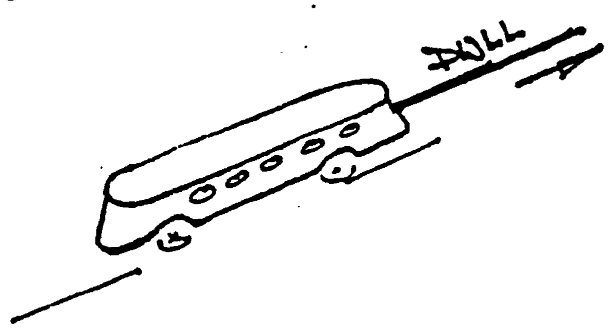
#4 NEGATIVE JET OR



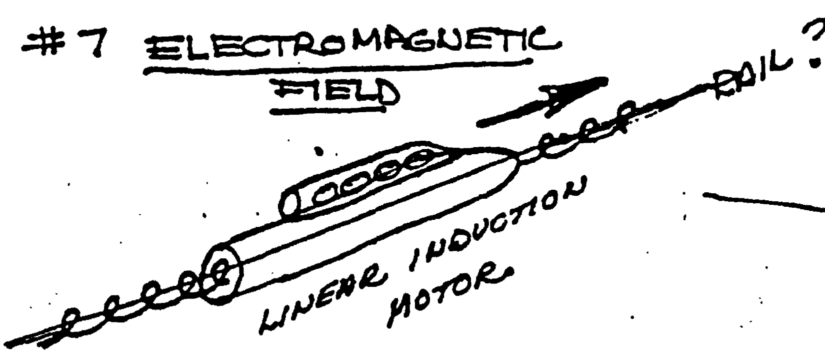
#5 MOVING ROLLER OR
BELT



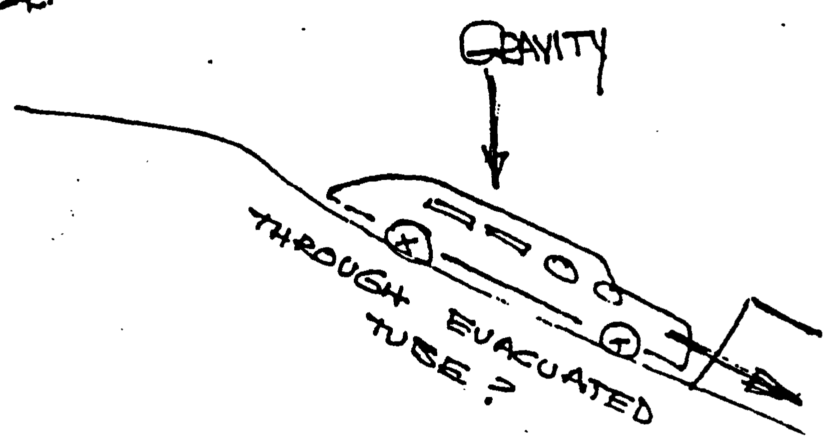
#6 CHAIN OR CABLE

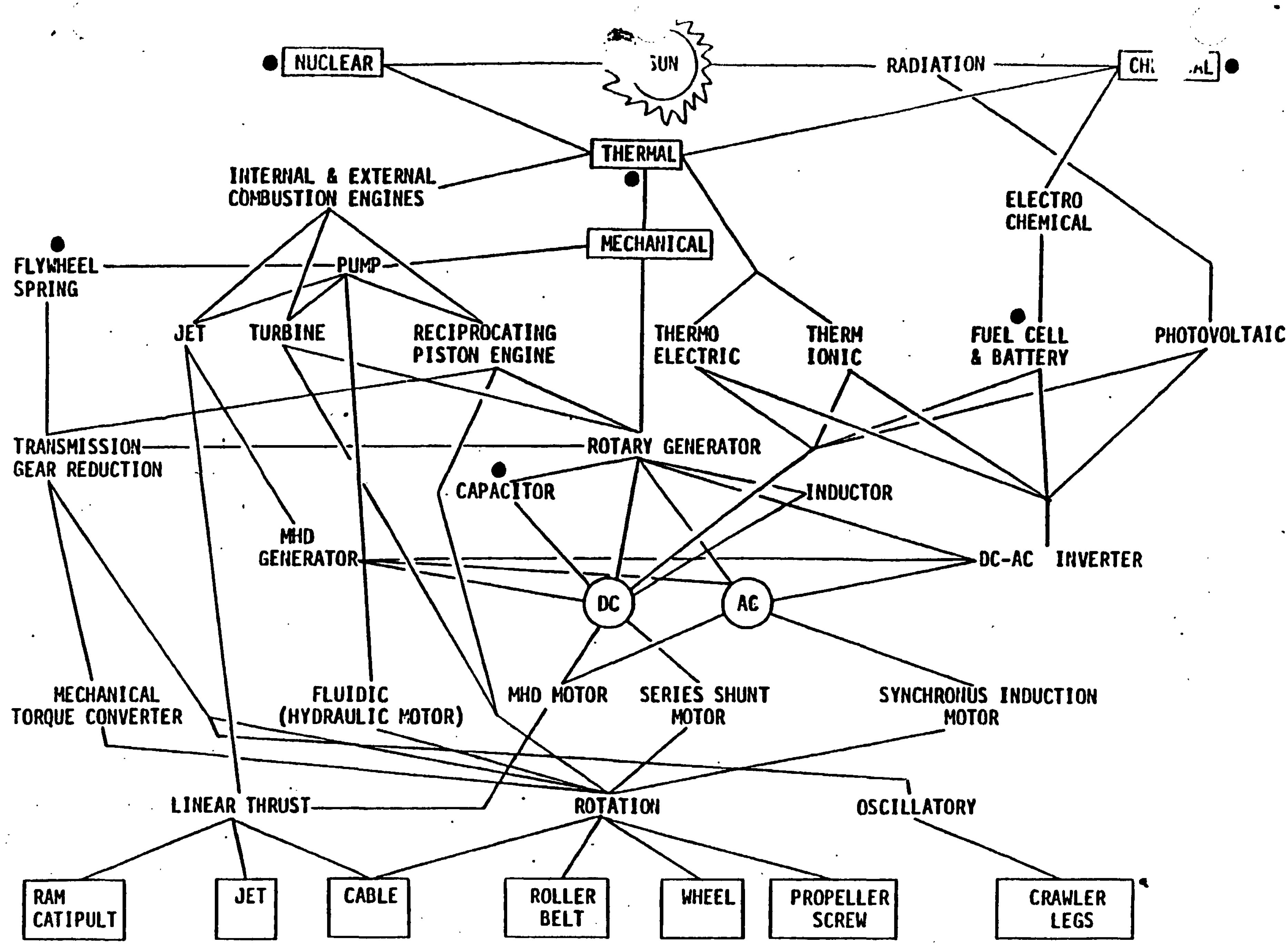


#7 ELECTROMAGNETIC
FIELD



#8 ROLL OR SLIDE
(GRAVITY)





TRANSPORTATION POWER & STORAGE

● *indicates storage*

C. Describe how the five characteristics (degrees of freedom, etc.) are influenced by energy conservation concerns.

Example: Vehicle: Locomotive

1. Degrees of freedom - 1st
   Such systems tend to de-emphasize great changes in acceleration/deceleration, which wastes energy for the sake of high power levels.

2. Autonomy of control - 2nd
   Delivers large loads of freight and numbers of passengers, as opposed to 1st degree situations.

3. Support and suspension - passive (wheel and axle)
   Does not require energy expenditure for support. Low coefficient of friction between wheel and rail.

4. Propulsion - backward push against earth
   Near 100% efficiency. Small friction losses.

5. Power - Hybrid (internal combusion/reciprocating piston engine/electric generator-DC/electric direct drive DC motor).
   The high efficiency of the diesel engine, combined with the high torque from zero RPM's of the electric drive motor.

D. Have students choose a vehicle and describe it in terms of the five characteristics of a transportation system.

E. Analyze transportation vehicles from the perspective of their degrees of freedom, while comparing them in regard to support and suspension systems and propulsion systems. Use a matrix chart for this vehicle comparison (see sample matrix).

1 - 1st degree of freedom
2 - 2nd degree of freedom
3 - 3rd degree of freedom

F. Using the systems of transportation chart for power and storage, have students trace the energy flow from the source of all energy on earth...the sun, to one of the seven methods of propulsion (see power and storage chart). Students should attempt at least five vehicle power systems for this exercise, noting areas of energy storage throughout the process.

Example: Automobile - the sun, radiation, chemical energy (storage), thermal energy, internal combustion engine, recip-rocating piston engine, transmission gear reduction, rotation, wheel.

G. Vehicle/transportation system paper and presentation.

Project requirements:

1. Choose a vehicle or transportation system.
2. Perform personal research.
3. Write a short paper (200-400 words).
4. Prepare an oral presentation (5 minutes) for class.

Specifications for paper and presentation:

1. Explain why you chose this vehicle or system.
2. Vehicle category: inter-city, urban, both?
3. Vehicle use: passengers, freight, both?
4. Vehicle characteristics: degree of freedom, control, support and suspension, propulsion and power required.
5. Energy storage: on board or delivered?
6. Fuel used (earth source).
7. Vehicle efficiency (overall).
8. Projected availability of fuel to the year 2000.
9. Vehicle range.
10. Vehicle top speed.
11. Number of passengers and/or freight tonnage.
12. Discuss the term "load factor" in relation to your given vehicle or transportation system.

NOTE: Students should also include information concerning social, economic and political implications for their system.

H. Students should have the opportunity to construct and performance test selected transportation vehicles, such as:

1. Model rockets (see performance data sheet)
2. Ground effects machine (see drawing)
3. Low drag ground vehicle (CO2 powered)
4. Model airplanes:
   - rubber band powered
   - glo-engine power, control line
   - glo-engine power, radio control
   - glo-engine power, free flight
   - tow-line glider
   - pulse jet power, control line

Activity Materials needed:

Resource materials on transportation, model kits, information sheets, engines, modelling supplies, tools and equipment.

Suggested references:

Model Aviation Magazine
1810 Samuel Morse Dr.
Reston, VA 22090 ($18.00/yr - 12 issues)

Model Builder Magazine
RCMB INC.
898 West 16th St.
Newport Beach, CA 92663 ($25.00/yr - 12 issues)

Model Airplane News
Air Age, Inc.
632 Danbury Rd.
Wilton, CT 06897 ($25.00/yr - 12 issues)

Building and Flying Indoor Model Airplanes.
R. Williams.

National Transportation Policies Through the Year 2000.
U.S. Govt. Printing Office. 1979.
Introduction to Transportation. P.W. DeVore.

Transportation: Technology of Moving People and Products. Alan R. DeOld et.al.

Suggested films:

America's wings
The dream that wouldn't down
A man's reach should exceed his grasp
The age of space transportation
ALL available from Audience Planners, Inc.

From Kitty Hawk to Aerospace
We saw it happen
How an airplane flies
X-15
Air Force missle test center
ALL from U.S. A.F. Central Audiovisual Library

Model Rocketry
From Modern Talking Picture Service

TEST STAND & FLIGHT TEST DATA COMPARISON:

SOLID PROPELLANT ROCKET

NAME ________________________ PERIOD _______

MODEL-NAME	ENGINE NUMBER	ANGLE ON ALTITUDE FINDER	DISTANCE FROM LAUNCH TO TRACKING STATIONS	TIME IN SEC. TO REACH MAXIMUM ALTITUDE	MAXIMUM ALTITUDE (FT)	AVE. VELOCITY MPH	FPS (1 MPH = 1.47 FT/SEC)	TOTAL IMPULSE (LB SEC)	SPECIFIC IMPULSE	
										TEST NO.1
										TEST NO.2

1. COMPARE EACH ENGINES TOTAL IMPULSE WITH THE VEHICLE ALTITUDE OBTAINED. WHAT CONCLUSIONS MAY BE REACHED HERE.

____

____

____

2. IF A B6-4 ROCKET ENGINE LIFTS A VEHICLE TO AN ALTITUDE OF 400' WITH A TOTAL IMPULSE OF 1.10 LB. SEC., IT FOLLOWS THAT A C6-5 ENGINE WITH A TOTAL IMPULSE OF 1.50 LBS. SEC. SHOULD LIFT THE VEHICLE TO A PROPORTIONAL ALTITUDE OR....

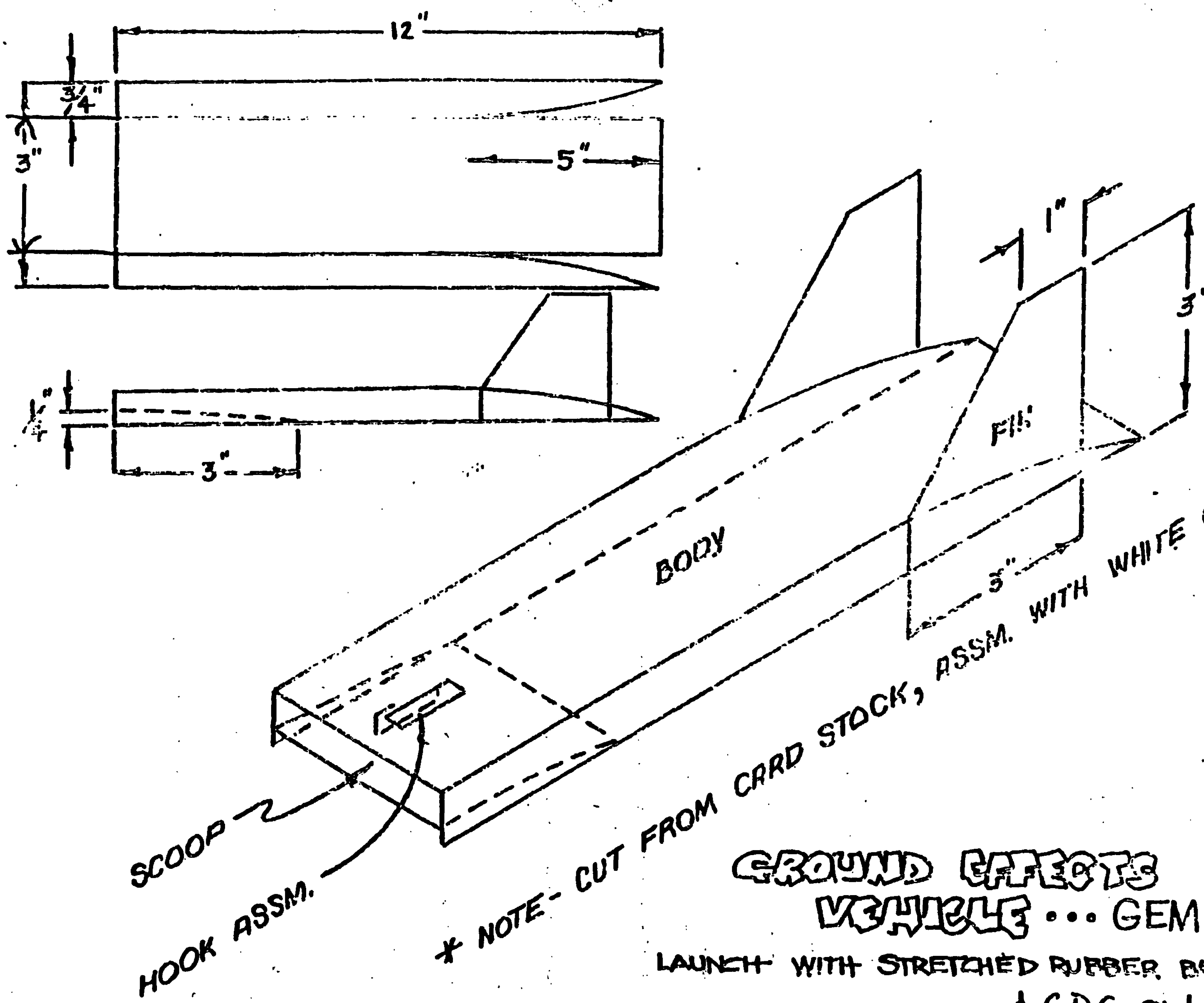
$$\frac{1.10}{400} = \frac{1.50}{X} \qquad 1.10\,X = 400\,(1.50) \cdots\cdots \quad X = 545'$$

FROM YOUR TESTS.... YOU WILL NOTICE THAT THE C6-5 DOES NOT ATTAIN THE PREDICTED ALTITUDE. WHY....

____

____

____



* NOTE- CUT FROM CARD STOCK, ASSM. WITH WHITE GLUE.

GROUND EFFECTS VEHICLE ... GEM

LAUNCH WITH STRETCHED RUBBER BAND.

C.D.G 81

TOPICS: I - II.

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$SUGGESTED RESOURCES

NOTE: The following resources are listed in order to assist the teacher in developing instructional strategies for the ENERGY APPLICATIONS syllabus. Resources are labeled in order to classify the item into the technology systems area which is of primary focus.

Labels are indicated by letter, as follows:

- Communications - C
- Human Needs - HN
- Production (construction) - PC
- Production (manufacturing) - PM
- Transportation - T

A more extensive list of resources is located in the ENERGY APPLICATIONS - RESOURCE SUPPLEMENT.

TOPICS: I - II

MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

SUGGESTED RESOURCES - PRINT MATERIALS

PC,PM,HN — ASHRAE. ASHRAE handbook. Atlanta, GA. American Society of Heating, Refrigerating and Air Conditioning Engineers. annual edition.

PC,PM — Barling, John. John Barling's solar fun book. Farisita, CA. EARS. 1980.

HN — Brown, Robert J. et.al. Introduction to life cycle costing. Altanta, GA. The Fairmont Press. 1985.

ALL — Burke, James. Connections. Boston, MA. Little, Brown & Co. 1978.

PC,PM,C — Calhoun, Elizabeth. 20 simple solar projects. Emmaus, PA. Rodale Press. 1983.

T — Deold, Alan R. et.al. Transportation: technology of moving people and products. Worcester, MA. Davis Publications. 1986.

T — DeVore, Paul W. Introduction to transportation. Worcester MA. Davis Publications. 1983.

PC,PM,T,HN — Dorf, Richard C. The energy fact book. NY McGraw-Hill. 1981.

C — DuVall, Barry J. et.al. Getting the message. Worcester, MA. Davis Publications. 1981.

ALL — Energy facts. Washington, D.C. National Energy Information Center. U.S. DOE. 1985.

ALL — Energy systems. (Technology Education Foundations Curriculum). NYSED. 1984.

ALL — Energy technology handbook. NY McGraw-Hill. 1977.

PC,HN — Falconer, Raymond C. Weather and climate. Albany, NY. SUNY Atmospheris Sciences Research Center. n.d.

PC,HN — Halacy, Dan. Home energy. Emmaus, PA. Rodale Press. 1979.

ALL — Hunt, V. Daniel. Energy dictionary. NY. Van Nostrand-Rheinhold. 1979.

OCR Paper

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JOB NO.________

PAGE NO. EA-43

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6 LINES INCH

HN	Keys, John. Harnessing the sun. Dobbs Ferry, NY. Morgan and Morgan. 1975.
PC,PM,HN	Kleinbach, Merlin, and C. Salvagin. Energy technologies and conversion systems. Englewood, NJ. Prentice-Hall. 1985.
PC,PM, HN	Leckie, James. et.al. Other homes and garbage. San Francisco, CA. Sierra Club Books. 1975.
PC,PM,HN	McPhillips, Martin. The solar energy almanac. NY. Everest House Publishers. 1983.
PC,HN	Mazria, Edward. The passive solar energy book. Emmaus, PA. Rodale Press. 1979.
T	National transportation policies through the year 2000. Washington, D.C. U.S. Govt. Printing Office. Supt. of Documents. 1979.
ALL	New York State energy master plan. Albany, NY NYS Energy Office. Annual edition.
PC,HN	Ramsey and Sleeper. Architectural and graphic standards. AIA. John Wiley and Sons. 1981.
HN	The residential energy manual. Atlanta, GA. Fairmont Press. 1985.
C,PM	Roberton, Edward ed. Solarex guide to solar electricity. Blue Ridge Summit, PA. TAB Books. 1983.
PC,HN	Steven Winter Associates. The passive solar construction handbook. Emmaus, PA. Rodale Press. n.d.
PC,PM,HN	Thumann, Albert. Handbook of energy audits. Atlanta, GA. Fairmont Press. n.d.
PC,PM,HN	Thumann, Albert. Fundamentals of energy engineering. Atlanta, GA. Fairmont Press. n.d.
ALL	Wattenberg, Benjamin. The U.S. fact book: the American almanac. NY. Grossett and Dunlap. annual.
T	Williams, Ron. Building and flying indoor model airplanes. n.p. 1981.

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ALIGN FIRST CHARACTER UNDER THIS ARROW — 6 LINES INCH

INSTRUCTIONS

TOPICS: I - II. MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$SUGGESTED RESOURCES - PERIODICALS

PC,HN — ALTERNATIVE SOURCES OF ENERGY
Route 2
Milaca, MN 56353

ALL — ENERCOM
NYS Energy Office
Two Rockefeller Plaza
Albany, NY 12223

HN — HOME ENERGY DIGEST/WOOD BURNING QUARTERLY
8009 34th Ave., South
Minneapolis, MN 55420

PC,HN — MOTHER EARTH NEWS
Box 70
Hendersonville, SC 28739

PC,HN — NEW SHELTER
Emmaus, PA 18094

ALL — POPULAR SCIENCE
380 Madison Ave.
New York, NY 10017

PC,HN — SOLAR AGE
Church Hill
Harrisville, NH 03450

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TOPICS: I - II. MODULE: ENERGY APPLICATIONS TO TECHNOLOGY SYSTEMS

$$SUGGESTED RESOURCES - ADDRESSES FOR FURTHER INFORMATION

ALTERNATIVE ENERGY ASSOCIATION OF AMERICA
P.O. Box 26507
Albuquerque, MN 87125

AMERICAN GAS ASSOCIATION
Educational Services
1515 Wilson Blvd.
Arlington, VA 22209

AMERICAN PETROLEUM INSTITUTE
2101 L St., NW
Washington, D.C. 20037

BIOMASS ENERGY INSTITUTE
304-870 Cambridge, St.
Winnipeg, Manitoba
CANADA

LOCAL UTILITY CONSUMER AFFAIRS OFFICE

NEW YORK STATE ELECTRIC AND GAS CORP.
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