Energy, Power and Transportation Technology 11

Guides

NOVA SCOTIA
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Energy, Power and Transportation Technology 11

Prepared by the Department of Education and Early Childhood Development

This is the most recent version of the current curriculum materials as used by teachers in Nova Scotia.

Energy, Power and Transportation Technology

Curriculum Guide No. 146

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NOVA SCOTIA
Education

Energy Power and Transportation Technology

Teaching Guide No. 146
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For many years Eric Warden, Industrial Arts Technology Consultant with the Department of Education and Culture, undertook the difficult task of updating Industrial Arts Technology Curricula in this province. The curriculum guidelines for the final three courses, Production Technology, Communications Technology, and Energy, Power and Transportation, mark the culmination of this work. These three documents are a memorial to Eric, who passed away in February, 1996, less than one month before they were presented at in–services for Nova Scotia's Industrial Arts Technology teachers.

Table of Contents

Energy, Power, and Transportation Technology

Energy, Power, and Transportation Technology (PET 11)is a full credit course available for all students at the senior high school level. Since it is activity based, it is recommended that extended class periods be scheduled in the timetable.

Inevitably the content of technology courses is soon outdated and teachers develop better activities to help their students learn. For these reasons, the Department of Education and Culture invites all readers to suggest new content and better ways of teaching. New technology means that guides can be updated regularly. Teachers and others are invited to send their suggestions to the Director of English Program Services.

RATIONALE

Sources of energy can be classified as exhaustible, renewable, and inexhaustible. All of these sources have their genesis within the solar system and are a direct result of the sun's effect on the earth or materials shaped during the formation of the earth. Power sources emanate from these sources of energy, through the use of energy conversion and control devices. Transportation systems convert energy into motion, and most transportation systems use vehicles to carry people and/or materials. The use of these energy conversion and control devices and the study of transportation systems is a significant part of a study of technology processing at the senior high level. This course augments the other two areas of production and communications.

HOW TO OFFER ENERGY, POWER AND TRANSPORTATION COURSE

This document outlines the core and supporting units of the Energy, Power and Transportation Technology course. In selecting units and activities teachers need to remember at all times the outcomes of the course.
The three core units, of which at least one must be offered, are as follows:

Unit 1–Electronics
Unit 2–Robotics and Automation
Unit 3–Mechanics

The supporting units, all of which must be offered, are as follows:

Unit 4–The Nature and Sources of Energy
Unit 5–Power Generation, Transfer, Control and Conservation
Unit 6–Environmental Impacts of Energy Power and Transportation

Since there is a strong correlation between each one of the core units teachers should offer more than one core unit. Although a significant number of the topics in each unit are of a theoretical nature, it is critical that there is a concentrated emphasis on a practical, hands-on approach. Numerous activities are suggested here; teachers should design the course to meet the needs of their students.

CURRICULUM OUTCOMES

By the end of the course students will be able to demonstrate an understanding of Energy, Power and Transportation Technology.

They will be able to:

- demonstrate an understanding of the function of energy, power and transportation in historical contexts and modern society
- demonstrate an understanding of the basic technology system and its application in energy, power and transportation

- analyse, critique and evaluate the application and outputs of a variety of methods used in energy, power and transportation technology and the design process in satisfying needs and wants

- demonstrate an understanding of the requirements for careers in energy, power and transportation

LINKS WITH THE ESSENTIAL GRADUATION LEARNINGS AND OTHER SUBJECT AREAS

Cross–curriculum links can be achieved as follows:

Communication

There are many possibilities for correlating technology studies and the development of the Essential Graduation Learnings for Communication. Students can:

- make spoken and written presentations of design proposals
- use books and data bases to research energy, power and transportation technology problems and processes
- use text in a variety of media, including guide books, textbooks, consumer reports, instructional manuals, information leaflets, forms, brochures, newspapers and magazine, publicity materials

Students will also have opportunities to write in a range of forms and for a range of purposes including describing, explaining, giving instructions and reporting simple activities. These could include:

- communication with industry. Re: specific energy, power and transportation project

- discussions and debates on contentious problems such as the potential of nuclear energy, transportation issues, energy conservation, etc.

- essays on the effect of power, energy and transportation on society

- development of an energy, power and transportation notebook composed of newspaper and magazine clippings, with personal notes and observations including a section on specific terminology and correct spellings

Mathematics

Mathematics has many correlations with energy, power, and transportation technology. For example:

- calculations of engine efficiency and mechanical advantage

- calculations of conversions from one measurement system to another

- scale use in drawing graphs, charts, etc.

- calculations of percentages of enlargements or reductions

- calculations for current, voltage and resistance required for different sized circuits

- calculations related to the consumption and energy efficiency of different types of energy sources

Science

Science is in evidence throughout the various aspects of energy, power and transportation technology. From computers to electronics there are many opportunities for correlations such as:

- conducting a solar energy collecting experiment

- monitoring the different insulation values of various materials

- judging the effectiveness of a tidal power plant

- simulating existences of the greenhouse effect

Extensive correlations can be also developed with the senior high physics curriculum especially in the areas of electricity and magnetism, forces, work and energy. For example in the motion unit reference can be made to the friction welding used to weld high speed steel twist bits to carbon steel shanks. Similarly a correlation can be made to hydrodynamic lubrication used in oil lubricated engines.

Citizenship

During the development of society humans have been involved in moving from place to place, either on foot, or by using aids in the form of animals or mechanical movements or both. The history of energy, power and transportation can be divided into three overlapping periods: the period when humans were dependent on animals and the wind, the period during which the steam engine and the internal combustion engine made for dramatic changes, and the era of space travel. Consequently, there are many opportunities to explore connections such as:

- global locations of energy sources and the place of Canada's resources
- implications of automation such as CAD, CAM, CIE, CIM, etc. on people in the work place
- the role of coal in the development and continued prosperity of Nova Scotia
- the ingenious ways various cultures have used energy sources to meet their needs
- the role of early transportation pioneers in the flight, rail and space domains
- the development of bridges and their effect on the environment (i.e., the Tacoma Narrows Bridge Disaster)

SUGGESTED TEACHING STRATEGIES

Discussion

Talk is essential to learning. As the whole class or small groups discuss, students are making sense of what they are dealing with as well as exchanging ideas with colleagues. Discussions can evolve spontaneously out of activities, mini-lectures and demonstrations or they can be arranged to deal with specific topics.

Inventing and Brainstorming

This is a quick way of producing a large number of different and novel ideas very quickly. Working in groups, students are encouraged to think of many ideas as quickly as possible.

Four ground rules of brain-storming are as follows:

- Do not criticize ideas -note them and continue
- Encourage "crazy" and "long shot" ideas
- The more ideas the better
- Combine and improve ideas

Technology Learning Activities

A technology learning activity (TLA) involves students working on activities to become more familiar with new technology in communications, energy, power transportation, and production areas. Usually students work in small or large groups and the activities include one or more of the following: problem solving, investigation, research, model making or simulation.

Cooperative Small Group Learning

Cooperative learning can be used to promote higher achievement among students, to facilitate learning involving students of different levels of ability, and to develop social skills. The experience of working in a group provides students with opportunities to reflect on their understanding and practice.

Cooperative learning can help students to develop the following skills relevant to the problem solving process:

- exploring and developing ideas
- working with other students
- generating alternative ideas
- listening and analysing
- checking for understanding
- sharing ideas
- role playing and simulation

- assessing previously learned knowledge
- individual thinking and self expression

The following are some ideas for structuring groups:

- use the multiple station workshop bench for a group structure base
- balance students' strengths and weaknesses for the pairs and/or groups
- test sample group structures during the workshop/lab cleanup schedule
- encourage sharing of responsibilities
- practise using groups or pairs for doing special tasks or projects such as
    - unloading material supplies
    - working on computer applications
    - sorting and cataloguing workshop/lab materials and supplies
    - measurement and surveying tasks
    - equipment and machine trouble shooting
    - focus orientation of lab or workshop

Cooperative learning groups require careful organization, observation and monitoring.

The Design Problem-Solving Process

Experience and research show that learning can be more effective when students' interests, experience and ideas are taken into account. This means not only helping students relate content to their everyday experiences but also involves them in perceiving and finding answers to their own questions, and exploring and developing their own ideas. The design problem solving process therefore uses teaching methods which actively encourage students to participate in the learning process.

Demonstrations

Demonstrations can be given to an entire class, a small group or an individual. They can help to provide students with an overview of a process.

Lectures

Short, well-prepared lectures can provide a quick overview of a topic or specific information on a particular concept or process.

Product Analysis

Analysing and evaluating products, are useful activities to increase students' awareness of everyday products and the technology used to produce them. This activity can be done by students working in groups or individually and is an excellent way of getting students to discuss purposefully.

Learning Contracts

A learning contract is an agreement between a student and teacher about virtually any expected kind of learning experience. It usually involves a clear statement of the purpose of what the student hopes to accomplish, as well as a description of the experience, the resources to be used, and the general time frame for completion of the contract. Usually provision is included for the content to be negotiated to accommodate changing circumstances.

Student contracts can increase student motivation and provide a strong sense of ownership, as well as providing opportunities for students to use their own strengths and learning styles.

Neutral Questioning Techniques

The role of the teacher in discussion and questioning sessions should be to facilitate discussion. To prevent the "guess what I have in my mind" approach, questioning should be as neutral as possible. In general it is important to help students articulate what they did and why, how they did it and why, and what they have learned.

In student responses, teachers should be looking for evidence of growth of understanding of products, processes, systems and environments.

Specific questions should promote reflection. For example:

- How did you . . . ?
- Why did you . . . ?
- What did you try . . . ?
- How do you know that . . . ?
- What would happen if . . . ?
- How do you feel about . . . ?
- Have you . . . ?
- How did you decide to . . . ?
- Can you describe . . . ?
- What do you think . . . ?
- If these statements are true, what do you think is most likely to happen . . . ?
- What would you do if . . . ?
- If this happened to your design, what would you do . . . ?
- What would you suggest in light of what you know about . . . products/systems/environments/ designing/technology . . . ?
- What else could you change/try . . . ?
- If you do not know what to do next, how could you proceed . . . ?

ENERGY POWER AND TRANSPORTATION IN DIFFERENT CULTURES

An early form of transporting people and heavy loads was pulling and dragging objects carried on sleds. The Inuit komatik (wooden sled) is a typical example, and included a unique feature whereby cross slots were built flexibly enough to facilitate travelling over rough terrain, such as that experienced where frozen sea ice joins the land.

A lightweight wheel composed of 12 spokes was developed by the Sintashta people of Kazatkstan at about 200 BC.

In very recent times, the speed at which people can travel, has developed so much that travel beyond the confines of the earth has become possible for astronauts. During the last few decades space travel has included men and women of many nationalities and cultures. For example, Lieutenant Colonel Guion Bluford became the first African American in space in 1983. A United States Air Force pilot from Philadelphia who flew 144 missions in the Vietnam war and was awarded ten air medals, he was also a mission specialist in 1985 and 1996.

ASSESSMENT OF STUDENT PROGRESS

Rationale

Assessment of student learning is at the core of successful teaching and learning.

It is a means for teachers to diagnose; to identify the learners' strengths and weaknesses - what they know, understand and can do; to remedy shortcomings; to involve the learner in evaluation and target-setting. Assessment provides the basis for planning future teaching and learning. It supports teachers in evaluating the effectiveness of their teaching. It provides a basis for reporting to parents on their childrens achievements.

Assessment: an integral part of teaching

The major portion of instructional time should be directed to practical activity and assessment should reflect such an emphasis. Teachers might refer to the following to assess the progress of their students:

- class participation
- notebook/journal/portfolios/binders
- technology learning activities
- research and development projects
- out-of-school study
- correlated study
- practical projects and problem solving
- individual take home projects
- simulation model-making projects
- group projects, especially the work done as a team member involved in the enterprise unit

Assessment of Learning in the Enterprise Unit

The progress of students working in the enterprise option will require careful development. Sometimes it will be appropriate for each member of the group to share the same assessment, but since not all activities require an equal amount of input or participation from all members, other strategies will need to be developed so that fair and accurate evaluation of the progress each student is making takes place.

Personal assessment can be helpful where students are asked to assess their own progress toward the objectives agreed upon by the group, and this assessment can be a good starting point for the teachers' assessment.

What should teachers assess?

Following are suggestions:

Skills of communication

- the ability to use effectively various kinds of language skills (reading, writing, speaking, listening), as well as nonverbal forms of communication such as graphic and electronic media

Skills of numeracy

- the ability to estimate, measure, understand and use numerical relationships

Physical and practical skills

- the ability to demonstrate manual dexterity and to coordinate body movements

Observation and visual skills

- the ability to observe accurately to record patterns and relationships using scale perspectives, shape and colour, and to interpret observations

Learning and study skills

- the ability to organize time and materials effectively, to use appropriate aids to learning, to weigh and interpret evidence and to draw conclusions, and to extract and classify information

Problem solving and creative skills

- the ability to diagnose the features of problems and propose feasible solutions, and to draw on ideas and use materials inventively

Imaginative skills

- the ability to perceive new situations, to discipline imagination by drawing on evidence and experience; to order, reshape experiences and images

Social skills

- the ability to cooperage and negotiate; to express ideas in a variety of contexts to consider other viewpoints; to create and sustain effective personal relationships and to cope with basic expectations of society

Assessment of Performance

Design

Indicators of low performance:

- little or no evidence of investigation or research
- when a selection is made only one solution considered or attempted
- some indication of research with negligible evidence of investigation or reading about the problem
- an attempt to consider alternative solutions but soon rejected for superficial or no reason

Indicators of high performance:

- some good research and investigation into the problem with the results well presented and good use of supporting illustrative material
- in-depth consideration of more than one solution with good stated reasons
- full evidence of good sound research and investigation into the problem
- good selection and presentation of data, and/or organization of experiments, written up and presented supporting work and conclusions

Production

Indicators of low performance:

- used resources from a narrow and mainly familiar range with little or no reference to suitability, cost, and availability
- developed no designs or plans for the production of the product / system/ environment

- used only simple processes in an illogical order to produce the product /system/ environment
- used only basic skills to produce the product/ system/environment

Indicators of high performance:
- used resources from a wide familiar and unfamiliar range with extensive reference to suitability, cost, and availability
- developed detailed designs and plans (in related stages) for the production of the product/system/ environment
- used advanced skills to produce the product/system/environment

PROGRAMMING FOR STUDENTS WITH SPECIAL NEEDS

An Industrial Arts Technology Education course has educational benefits for all students, including students with special needs. It is important that teachers become aware of each student's unique educational needs and then plan instruction to meet these needs.

All the students in any industrial arts technology program will have a variety of strength areas, and a small percentage of such students will also have educational needs that may be different from the majority due to physical or cognitive disabilities. It is desirable for these students to participate in an industrial arts technology program that is aimed and developed with the total educational needs of these students in mind, rather than concentrating on a specific disability.

When teachers are planning programs for such students, they should attend to the following points; the needs of the particular student, the strength areas, any medical condition or physical limitations that will influence the students success, the provision of safe facilities and accessories.

In general the overall aims and goals of the program will remain the same as for all students, but those intended to develop self confidence, problem solving ability and specific technical and manipulative skills may require a reduced number of objectives. Learning activities should be presented in both practical and concrete approaches. While it is true that the depth and extent to which the material is presented and covered should be in accordance with the aptitudes of the student, the teacher should not lose sight of the opportunity to choose practical activities and project themes which have the potential for offering basic occupational preparation and the development of specific base work skills.

It is recommended that adequate consideration be given to the following aspects of planning for students with special needs:

Planning for students with special needs

- Conduct assessment and if necessary, develop an Individualized Program Plan (IPP) with a team.
- Individualize Instruction.
- Use contracts and independent study.
- Consider cooperative teaching.
- Evaluate all resource materials, especially reading materials, to determine their appropriateness.
- Invite the special education and resource teacher to the workshop/lab to learn about the program and to review students' strengths and needs and appropriate teaching and evaluation strategies.
- Set review dates and ongoing meetings to work with the special/resource teacher and any other support personnel necessary (eg. an occupational therapist) in planning the IPP.
- Develop lists of terminology used in the course and advise the special education/resource teacher and reading specialist of these words.
- Try to involve the use of as many senses as possible. Smell: different materials such as wood shavings, and lubrication oils. Sounds: different sounds of cutting, shaping, hammering, and sawing. Sight: the colour of different materials and processes such as welding.

- Rely more on performing tasks and talking through the steps and procedures involved while the students observe. Then encourage them to perform the task at the same time as talking themselves through it. Present and implement steps one at a time.
- Use progress charts that provide constant feedback.
- Use the cooperative small group learning approach where appropriate including pairing of students with complementary strengths (e.g., a weaker reader who has good drawing skills with another student who can read well but has difficulty drawing.)
- Use concrete examples continually, including models and graphic charts.

Additional Techniques

The following are a sampling of techniques that may be considered in meeting a variety of student needs. However, it should be noted that each student's program plan will provide the teacher with the direction necessary to ensure appropriate strategies and modifications for each student.

Gifted and Talented Students
Encourage the design technology approach, including research and development, problem solving, and brainstorming. Use mentor ships and teaching modules from appropriate sources and situations.

Students with Physical Disability
The physical nature of the shop or the lab may require some modification for this type of student. The following may be necessary:

- two routes to accommodate the wheelchairs
- hand bars on walls, benches and machines
- ample safe passage ways around benches, technology learning stations and machines
- modified furniture, benches, and machine tools
- provide - depending on the severity of the disability - special devices for keeping tools and pencils from falling to the floor
- employ a buddy system
- plan learning experiences based on the student's strengths

Students with Speech Impairment and/or Communication Disorders

- Use diagrams, pictures and charts often.
- Label tools, machines and work stations, etc.
- Pay full attention to students' speech.

Students with Hearing Impairment
When teaching the student with hearing impairment use visually oriented media extensively. Keep instructional sessions short. If possible, always face the student when speaking, and speak in a natural tone of voice. Use short sentences, make the most of body language, and re-phrase when necessary. Proper amplification for hearing impaired students is vital; warn students that have hearing aids to adjust their aids when turning on certain machines.

Always precede actual instruction with demonstration. Develop some competence in communicating by using manual instruction such as sign language, finger spelling, mime, etc. Maintain eye contact with the student, and to aid lip reading, maintain visual contact. Introduce procedure outlines and vocabulary lists for a complicated topic and ensure students pay full attention. Use visual aids and written materials as well as peer-note taking systems.

Students with Visual Impairment
The following learning modes are important to visually impaired or blind students:

- memory
- imagery
- auditory perception
- factual perception
- kinaesthetic memory

All of these should be used for improving instruction.

- Encourage the memorization of procedure steps for the correct use of tools and machines.
- Encourage the thorough touching of tools, machines, and materials.

- Encourage the development of the correct sound recognition of tools, machines and processes as they are being used (cassette tapes may be helpful here).
- To assist visually impaired students, place guards and bumpers, guide posts or rails around the machinery.
- Proper lighting is essential. Give the students the level of light they need to work comfortably.
- Providing it is made safe to do so, allow the students to position themselves so that their eyes are close enough to do the work.
- Make special jigs and fixtures to assist the student in the use of certain machines. For example a round, clear, plastic guard placed over the work is useful in many cases. This helps the student to know exactly where his or her fingers are in relation to the cutting edge of a blade.
- Make no major changes in the location of either equipment or materials without making the students well acquainted with these changes.
- Use the student's name when communicating.
- Give consistent, clear directions.
- Keep physical plant rearrangements to a minimum and inform student when changes are made.

Students with Intellectual Impairments

- Organize learning in small incremental stages.
- Provide constant feedback and positive reinforcement.
- Facilitate peer teaching and cooperative grouping techniques.
- Use imitation and modelling techniques.
- Use demonstration and provide as much visually oriented instruction as possible (advance organizers).

Students with Emotional and/or Behavioural Disorders

- Tasks should be kept simple with a small number of elements.
- Establish one goal at a time in a step-by-step method.
- Provide sufficient practice opportunities.
- Give frequent praise for correct effort and good achievement.
- Try to control visual and auditory distractions.
- Use a consistent structure and routine.
- Use discipline which is firm, fair, and consistent, and understood by the student.
- Use positive reinforcement constantly.

Students with Learning Disabilities

- Use A-V materials, tape cassettes, films and filmstrips.
- Double-space handouts and highlight key words.
- Keep assignments as directed as possible giving one task at a time.
- Pre-teach unknown terminology.
- Ensure that questioning strategies allow time for the student to process the question and produce an answer.
- Modify evaluation strategies to meet students needs, while still assessing course objectives.

CAD and Students with Mobility Impairment

Adaptation of hardware and the use of special software may be necessary for students with mobility impairment. Input devices such as the joystick and mouse may possibly be used together with some minor adaptation such as a small extension to the joystick handle.

The working environment may also require adaptation such as ensuring that the doorways and aisles are wide enough to allow for wheelchairs.

Assessment

Assessing students with special needs should be part of the student's individual program plan. Alternative assessment methods may be developed. Such assessment could include outcomes in the following areas:

- Inclusion and participation
- Accommodating and adaptation
- Contribution

- Personal and social adjustment
- Academic and practical literacies
- Achievement and satisfaction

Careers in Energy, Power and Transportation

The energy power, and transportation industry offers a wide variety of careers. Participation in the industry by women has always been significant and has been increasing in recent years. The percentage of women in the workforce employed in energy, power, and transportation technology and related industries will increase, and there will be substantial opportunities for students with interests and abilities in these areas.

Safety Program

The nature of industrial arts technology education requires that correct safety practices be established as soon as students commence their studies. The teacher must provide instruction so that students work safely in school production laboratories, classrooms or elsewhere. It is of paramount importance that the teacher establish a comprehensive safety program and develop a wholesome safety consciousness among students. The following is a list of considerations which should be included in all safety programs:

General Safety Considerations

- Before a student may operate a machine the student must pass a test covering the essential points of technical knowledge and safe procedures in operating this machine. This test should be recorded and kept on file.

- Students should be dressed correctly and safely before operating any machine. Students should be instructed to dress so that no part of their clothing constitutes a hazard when operating a machine or tool or participating in a course activity.

- Guards should be kept in place during the operation of all machines and equipment.

- The teacher of an industrial arts technology program or course must remain in the workshop, classroom, or laboratory area of instruction at all times when the program is in operation. If the teacher has to leave in the case of an emergency, the power should be shut off and appropriate instructions left with the students.
  Note: For specific integral areas in the lab such as a dark room or tool storage area the teacher should institute procedures which facilitate student safety, for example, adopting a buddy system or utilizing safety monitors.

- All portable electric motor-driven machines must be adequately grounded.

- Procedures should be established to ensure that the instructional area is kept in good, clean and safe condition. Excessive dust and dirt and accumulation of waste materials contribute to a careless attitude toward safety. Production laboratory cleaning procedures should be established and form a continuing part of any program.

- An organized plan for maintaining tools and equipment should be an important part of any safety program. For example, sharp tools are safer than dull tools, and a student will do better work and develop correct techniques if tools are always kept sharp and in good condition. Broken tools should be removed from service until they are repaired or replaced.

- Most machines need to be operated by one person only and therefore observers or students waiting to use a machine must stand clear of the operator's zone. Specially designated machine operation zones can be instituted to assist in this regard.

Specific Safety Considerations

Control System
If a design is controlled by a mechanical, electrical/ electronic or pneumatic system it should be checked to work as expected.

Mechanical System
If a mechanism is powered by electricity it should be tested before switching on to ensure that belts do not slip and that gears work safely and that the appropriate guards are in place.

Electrical/electronic System
All parts should be fully insulated and grounded and the circuit should be checked for short circuits.

Pneumatic System
The system should be checked before switching the compressed air on. The components in the circuits should be checked before switching on to avoid possibility of injury to those operating the circuit.

Materials
Materials should be safety checked in relation to:

- Are they strong enough to carry the loads ad stresses?
- Are they flexible or rigid enough to resist stresses and strains?
- Are they strong enough to stand up to the working conditions?
- freedom from sharp edges and corners

Fire and Other Disasters
A workshop, laboratory, classroom or worksite used to offer an industrial arts technology program can present many hazards and it is important that precautions be taken to prevent possible accidents or disasters. The following factors need to be considered:

- It is recommended that school systems ask their local fire departments for recommendations regarding the type and capacity of extinguishers to be placed in each production laboratory.
- Students should know and understand how fire extinguishers work. Operating instructions should be fastened to the outside of the container.
- Fires are less likely to start in production laboratories that are clean. See housekeeping section above.
- Properly designed containers should be provided for each kind of scrap and waste material and should be emptied daily. Rags used to wipe up oil, paint, or other flammable liquids should be placed in a safety container, with a self-closing cover.
- Flammable materials, such as wood and metal finishers, solvents, and cleaners, must be stored in steel cabinets and must have the correct WHMIS designation.
- Electrical equipment, should be checked regularly for defects and worn live wires. This is especially important where extension cords are used with lights and equipment.
- Electrical equipment, such as soldering guns and coppers and heating elements, should be inspected daily to ensure that they are not left turned on. This should be part of the end-of-session housekeeping procedures.
- Gas equipment should to be checked frequently for leaks. All defective equipment must be replaced immediately.
- Special precaution procedures should be established to light and operate gas powered and fuelled equipment.

- Evacuation procedures should be established and practised regularly by the students.

- Specifically, students must know the signal used for a fire drill, how to stop work safely, which exit and alternative exits to use, and what to do when outside the building.

First Aid

- A cabinet to be used exclusively for first aid materials should be provided for each production laboratory or worksite. The cabinet should be sanitary and dustproof and compartmentalized so that it is easy to determine if any materials which need updating.

- Local or provincial health officials should be contacted for information about the amount and kinds of first-aid materials that should be contained in the cabinet.

- Procedures should be established for recording and reporting accidents. School authorities should be consulted to establish the proper procedures and necessary forms to be completed.

Colour Coding

Workshops and laboratories that are colour coded provide students with a pleasant place in which to work and learn. Colour coding also emphasizes safety by helping students identify potential hazards in the workshop situation.

The standard colours used for identifying specific hazards are as follows:

<u>Red</u>–generally indicates danger. It identifies fire protection equipment and emergency stop buttons and switches.

<u>Orange</u>–indicates dangerous parts of machines or equipment.

<u>Yellow</u>–indicates caution. It is the standard colour for working hazards that can result in accidents.

<u>Green</u>–designates the location of first aid and safety supplies and equipment other than firefighting equipment.

<u>Blue</u>–is used for informational signs. In some situations it replaces the excessive use of orange.

<u>Black and white,</u> and combinations of black and white in stripes or checks are used for housekeeping and traffic markings.

Examples of items in the workshop and the correct colour identification are as follows:

<u>Red</u>–fire extinguishers, emergency stop switches, fire exit signs, cans and cabinets that contain flammable material

<u>Orange</u>–the following parts of a machine: parts that cut; parts that crush; parts that shock; guards that cover pulleys, belts, and blades; machine switch-box covers

<u>Yellow</u>–parts of a machine that move and make adjustments, such as hand wheels, knobs, adjustable levers

<u>Green</u>–first aid kits with a white cross; safety bulletin boards; general information and safety supplies

<u>Blue</u>–the outside of large switch boxes

<u>A non-gloss pale blue, green or grey</u> can be used to identify the main body of all machines other than specific parts listed above.

Safe Machine operation

The following is a sample machine operation safety program. It is included here as a guide for teachers.

Various methods have been used for preparing students to operate power equipment. One that has been used and found quite workable is to require each student to pass a test similar to the procedure for securing a driver's license.

To begin, the teacher has an introductory lesson for the whole class on the particular machine. Students are then required to read and study the corresponding material in their textbooks. The teacher can then schedule a test in which the students answer questions concerning the care and safe operation of the machine. An alternative method is to allow students to write the tests as they are required, making certain that all of the necessary machines are covered by a certain date. The advantage of this is that the more progressive students may proceed at a faster rate than slower students.

Upon completion of the test (and a high percentage should be required for a pass, plus the correction of all mistakes) a practical test must also be done. Under the teacher's supervision, each student must demonstrate how to adjust and operate the machine properly. Any errors or unsafe procedures should be pointed out at this time. Having shown his/her ability to operate the machine safely, the student is given an operator's permit which must be shown when asked. A good plan is to have the license stapled to the student's notebook (this places a little more emphasis on having the notebook in class).

Lasers

Even though the power of a helium-neon laser is low, the beam should be treated with caution and common sense because it is intense and concentrated. The greatest potential of harm from the laser is to the eyes. No one should look directly into the laser beam or stare at its bright reflections, just as no one should stare at the sun or arc lamps.

Always observe the following:

1. Never look into the laser beam.
2. Never direct the laser beam into the eyes of another person or animal.
3. Do not operate the laser without the teacher's permission.
4. Operate the laser only with prior instruction.
5. Use the laser only for the designated purpose.
6. Always turn off the laser when finished using it.

Video Display Terminals (VDT)

According to authorities no radiation hazard is emitted from VDTs. Measurements of X-ray, radio frequency, ultraviolet, infrared and visible radiation associated with VDTs show that exposure levels from display screens are well below current exposure standards. However, extended eye exposure can lead to fatigue and eye irritation. Similarly, muscle strain of the neck and back often occurs with long sitting sessions or improper positioning of the equipment. Since students will only be involved with computers for short periods of time, these hazards should not present any difficulty. Computer equipment should be positioned so that it is convenient to use and away from other potential hazards.

Working with Polymer Materials

Adequate ventilation is essential when working with polymer materials. It is also important to protect the eyes from dust, particles of waste, and organic liquids. Note: the catalyst used for curing polyester resin can be hazardous to the eyes, and it must be used only under direct supervision of a teacher and by using the appropriate dispenser. Disposable plastic gloves are highly recommended when some polymer materials, for example glass fibre, which can irritate the skin. It is recommended that hands be washed thoroughly after using resins and catalysts.

USEFUL MATERIALS FOR WORKING MODELS AND PROTOTYPES

- Construction kits, Fishertecnik, Lego Technik, Meccano Erector, Polymak are examples of construction kits available from commercial supply houses.

- Corner reinforcement joints for small cross-section lumber or small-section lumber can be jointed quickly by using cardboard gusset plates, which can be glued and reinforced by using an appropriate size of metal staple.

- Low-relief modelling is a procedure that employs a base board of heavy cardboard on which levers and linkages are modelled. The levers and linkages are modelled full size or to scale using cardboard, foam core or very small section wood. Small paper clips and push pins are used as pivot joints for the levers and linkages.

- Electronic kits - Various commercial kits are available as follows: those that use multifunction and specific function boards, those that employ solder-less prototype boards; and those quick - wiring techniques. Examples include: Micro Electronics for All (MFA) Unilab System Omega, Alpha subsystem boards by Unilab; EKI Mr Circuit.

- Printed circuit board press and peel by Techniks Incorporated.

- Pneumatic and hydraulic systems are available from construction kit producers such as Lego, Fishertechnik, and Unilab.

Energy Power and Transportation Units

UNIT 1–ELECTRICITY AND ELECTRONICS

OUTCOMES

Students should be able to:

- explain electricity in terms of the behaviour and control of electrons
- define voltage, amperage, and resistance in terms of electrons, and recognize series circuits, parallel circuits, and series parallel circuits
- identify and verify series and parallel circuit operation
- identify and apply the fundamentals of Ohm's law
- distinguish between analog and digital devices and circuits
- recognize and name the basic components used in electronics
- identify the schematic symbols of electronic components, understand and follow electronic and schematic diagrams
- recognize and demonstrate the effects of capacitance and inductance in a DC circuit and an AC circuit
- explain and give examples of the properties of permanent magnetism and electro-magnetism
- explain the characteristics of AC current and voltage
- recognize and identify the characteristics of semi-conductors and properties of PN junctions
- explain and test the device parameters of diodes and transistors
- identify integrated circuit logic memory
- explain logic gates, how they are constructed, and how they work
- combine logic gates to build complex digital devices like clocks, flip flops, and timers
- apply and display the principles of Boolean algebra to digital circuits
- calculate amperage and wattage according to Ohms law and Watts law
- define and demonstrate voltage drop in simple circuits, and explain the difference between direct and alternating current
- distinguish and use electronic components, such as diodes, transistors, integrated circuits, and microprocessors
- list and apply general safety rules procedures in the study of energy, power, and transportation
- identify, manipulate, and use the basic controls of an oscilloscope, and set up and display various electrical wave forms
- calculate and test unknown voltage current resistance or power in a simple circuit using Ohms law
- connect, evaluate, and troubleshoot linear integrated circuits

- connect, evaluate, and troubleshoot digital integrated circuits subsystems

- breadboard/simulate, operate, test, and troubleshoot various electronic circuits

- employ electronic components to control electric current, e.g., resistor and LED

- employ switching devices that use small amounts of energy to control much larger amounts of energy, e.g., relays

- operate test equipment to find faults in circuits, e.g., resistance, metre, multimeter, and continuity tester

CONTENT

Fundamental Electricity/Electronics Review

- basic electronic theory
- resistor colour codes
- using solder less circuit boards
- resistance
- magnetism
- capacitance
- resistor and capacitor applications
- coils
- transformers
- semi-conductor devices
- diodes

Advanced Electricity/Electronics

- transistor
- photo diodes
- photo transistors
- photo thyristors
- linear integrated circuits
- switching and regulating current
- logic circuits
    - digital circuitry
    - truth tables
    - timing devices and diagrams
    - logic gates
- digital integrated circuits
- analog integrated circuits
- circuit assembly tips

Programmable/Computer Controller

- motor control
- slipping motors
- transducers
- languages
- signal transfer

SAMPLE ACTIVITIES

Have Students:

- draw/model the composition of an atom and label the different parts

- demonstrate electron flow from a negative to a positive battery terminal and electron versus conventional flow.

- practise reading the resistor colour code system and identify the value and tolerance of a variety of resistors

- view a cross-section of a solder less circuit board to observe how it makes connections and practise making and removing basic electronic components, such as a power source, resistors, capacitors, LEDs, and transistors

- construct simple circuits to observe the operation and function of basic electronic components, including resistor, potentiometer, photocell, capacitor, speaker, diode, SCR, NPN and PNP transistors

- design, build, and test various electronic circuits utilizing the components to perform useful functions such as:
    - burglar alarm
    - an automatic night light
    - DC power supply
    - metronome
    - blinking lights

- continuity tester
- audio generator
- variable timer

- practise identifying circuits that control current by switching it on and construct and analyse the following digital gates:
  - a logic indicator
  - an AND logic gate
  - an OR logic gate
  - a NOT logic circuit
  - a YES logic circuit
  - a NOR logic gate
  - a NAND logic gate

- use a knowledge of logic gates to construct a variety of circuits such as:
  - a two-gate clock
  - a two-gate timer
  - a basic memory circuit
  - a binary counter
  - a decade counter
  - a digital counter with display
  - an up/down counter with display
  - a multiplexer / demultiplexer
  - a logic probe
  - a one-shot touch pulse generator
  - an on/off touch switch
  - a random number generator

UNIT 2 - ROBOTICS AND AUTOMATION

OUTCOMES

Students should be able to:

- describe the basic feature of a robot for both low and high technology applications such as axis manipulators, actuators, controllers
- describe the use of electric and fluid power systems as used in robotics
- describe the operation of a microcomputer, and list the major developments in the evolution of the computer and its application in an automated control system
- identify the use of robots in modern industries and discuss their social and economic impact
- explain what is meant by an automated control system, and demonstrate the three separate functions; sensing, control, and operating

CONTENT

Major Elements

- definition of a robot
- mechanical: limbs, arms, joints, end effectors
- power supply: hydraulic, pneumatic, electric
- types of electric motors
- transmission systems: cables, bands, notched belts, gears
- sensors and transducers
- tactile, electrical, optical
- computer-fixed programs
- microprocessor

Interfacing

- parallel serial communication
- AC-DC controller
- Lafort interface
- NSTC interface
- ADR 101 interface
- programming in Q-basic
- traffic light
- DC motor control
- $C0_2$ timers
- analog sensing
- robot control
- CNC programming

Terminology

- CAD/CAM/CIM
- cartesian armed robots
- continuous path control
- cylindrical or jointed spherical co-ordinates
- degrees of freedom
- end effectors
- hydraulic robots
- manipulator
- non servo
- point-to-point
- servo
- WFMS–flexible manufacturer system

Robot Classifications

- cartesian coordinates
- cylindrical coordinate
- polar coordinate
- revolute coordinate

Work Cell

- computer
- micro programmable controllers
- mill/lathe
- conveyors/ carousels

Application of Robots

- sorting
- assembling
- carrying
- welding
- painting
- grinding
- carrying

UNIT 3 - MECHANICS

OUTCOMES

Students should be able to:

- compare and contrast different types of engines, including their historical development under the following categories: internal, external, intermittent, continuous, reciprocating, rotary and describe the working principles of at least one engine in each category
- name five applications of small engines and describe design variables used in small gas engines
- describe how jet engines operate, and explain the operation of two types of rocket engines used in the space exploration programs
- analyse the technologies used to change power to different torques and/or horsepower, and relate how power is controlled in a mechanical energy system
- define transportation technology, and describe the importance of the four major categories listed as terrestrial, marine, atmospheric, and space
- identify different types of land transportation systems and the need for them, including bus, truck, automobile, and rail
- describe the two major categories of marine systems - inland and ocean - and provide examples of the variety of modes used
- state the economic and social impact of air transportation and its value to society and the supporting agencies
- list the basic aviation principles dealing with aerodynamics, and identify the important parts of an aircraft
- describe and demonstrate the purpose and operation of small engine systems, including ignition, cooling, fuel, lubrication, starting, and exhaust systems
- identify and perform various service procedures and trouble-shooting tasks used on small gasoline engines
- describe and illustrate the differences between the operation of two and four cycle engines of both gasoline and diesel variety
- explain and illustrate in graphic form the operation of several continuous combustion engines, including the Sterling, gas turbine, and steam turbine
- distinguish and demonstrate at least three ways of transmitting power to machines, and solve problems involving simple machines to effect mechanical advantage
- demonstrate how gears, pulleys and belts, sprockets and chains, clutches, and couplings are used to control and or change the direction of power

CONTENT

Major Element

- definition of mechanical power
- principles of machines
- measuring mechanical power
- mechanical advantage
- power transmission
- small engine operation
- mechanical systems
- lubrication and cooling systems

- fuel and exhaust systems
- ignition and starting systems
- safety
- small engine maintenance
- storage procedure
- trouble-shooting procedure
- application of small engines

Automotive Systems

- charging system
- cooling system
- exhaust system
- fuel system
- ignition system
- lubrication system
- mechanical system
- power train
- starting system

Transportation Systems

- needs and values
- technology systems
- land
- marine
- air
- space
- intermodal
- other

Transportation Power Sources

- external combustion systems
- internal combustion systems
- gasoline automotive engines
- diesel automotive engine

SAMPLE ACTIVITIES

Have students:

- survey the lab environment to catalogue the different types of power drives used, such as v-belts, roller chains, and sprockets

- construct a low-relief model of the operation of a lock and key to illustrate the inclined plane

- build a model using either small tweezers or nail clippers to illustrate second and third-class levers

- take apart discarded appliances that use simple mechanisms to observe the system of levers and mechanisms used for operation (e.g., bathroom scales, computer hard drive, drawer lock)

- use a construction kit to construct a variety of compound gear systems and gear trains utilizing spur gears and pinion gears to solve specific problems

- use a crank and slide mechanism to solve a design problem

- design a cam and follower for the operation of a simple mechanism utilizing resistant materials such as wood, metal, or plastics

- design a device to sort discs or ball bearings of different diameters

- using resistant materials and/or construction kits, design and construct a remote control robot arm for use in a hazardous environment

- inspect an everyday object that embodies a basic mechanism, identify it as either a lower or higher form of mechanism, and use a CAD or DTP program to construct the appropriate kinematic diagram

- use a construction kit to design, construct, and test a mechanical system

- trouble-shoot some or all of the following small engine operation problems:
  - engine fails to start or starts with difficulty
  - engine misses and lacks power or surges
  - engine overheats
  - engine vibrates, knocks or is noisy

- design an engine "fails to start chart" including possible causes and remedy procedures

- compare the parts of four-stroke engine to those of a two-stroke engine

- use a computer aided drawing program (CAD) to load up a drawing of a piston rod and its connecting rod, and label the major parts

- remove the cylinder head from a small four-stroke engine, turn the crankshaft slowly by hand, observing the action of the valves during each of the four strokes, and identify the intake and exhaust valve overlap

- remove the valves from a four-stroke engine, examine their condition, replace them, including the springs and retainer

- take off the crankcase cover from a four-stroke engine and locate the valve timing marks on the timing gears

- withdraw the piston connecting rod assembly from a four-stroke engine and measure the piston ring side clearance; remove one ring and measure its end gap

- dissemble a two-stroke engine and identify the following parts: crankcase, crankshaft, cylinder, intake port, exhaust port, reed valve, connecting rod and cap, piston and piston rings, carburetor

- locate and clean carefully the exhaust ports in a variety of small two-stroke engines

- manoeuvre the shroud from a lawnmower engine and clean the cooling fins with a wire brush, then replace

- take off the water pump from an outboard engine, clean the intake screen, the rotor, and the housing, and replace all the parts carefully

- identify the different lubricating methods used in small engines and drain and change the oil on a four-stroke cycle engine

- start a small engine and use a screw driver to adjust the idle speed and mixture screws for the best engine performance during idle phase

- adjust the breaker points on a small engine magneto to the correct gap

- remove, clean, and regap a spark plug and check electronic ignition system to see if it is producing a spark

- ready a small engine for winter storage, and also return a small engine for use after storage

- participate in a small engine troubleshooting contest with a variety of tasks to be performed within a certain amount of time

- use a construction kit to fabricate a model vehicle and test it on a model dynamometer

- salvage from scrapyards or local garages discarded engine parts and use these to design a display of "cutaway" parts
- design an exhaust system so that small engines can be tested in the lab area
- design a stand to hold vertical shaft engines while they are being serviced
- use resistant materials to construct a wooden working model of a Wankel engine, including the rotor and its housing, or a cutaway model of a ram jet engine
- construct a battery-operated model car, air plane, or boat, and demonstrate its operation
- construct a model sailboat or air plane that can be manoeuvred by remote control
- use a compute-aided drafting program or a desktop publishing graphics program to design a map illustrating the best routes used to bring students to your school, and do an analysis of the distances travelled
- use a computer program like *PC Globe* to map and locate the major transportation routes in the world (land, sea, ocean or air); also use the program to locate major energy supplies;
- design and construct a wind tunnel that can be used to demonstrate the aerodynamic qualities of model vehicles, e.g., automobiles, aircraft, spacecraft, etc.
- participate in one or more of the following TLAs:
  - Small Engine Technology
  - The Automobile
  - Motorized Vehicle and Dynamometer

UNIT 4 - NATURE AND SOURCES OF ENERGY

OUTCOMES

Students should be able to:

- say where fossil fuel resources are located in Nova Scotia, and identify different types and characteristics
- define how petroleum exploration takes place, and describe how it is produced and transported
- summarize the characteristics and describe the refining of natural gas, and detail how it is distributed in Canada
- identify the six major forms of energy, and state the meaning of the laws of energy conservation
- define energy, explain how it is able to produce motion, heat, and light, and recount the terms used to measure energy
- pinpoint the energy source in different products that are being produced
- explain the terms work, energy, power, and foot pounds and state the use of the formulas for work efficiency, power, and horsepower, and the difference between kinetic and potential energy
- specify the extent to which nuclear energy is used in Canada, and define nuclear fusion
- describe how energy originates and explain how it is converted into controlled forms used in residential, industry, business, and transportation situations
- recognize several principles of solar-derived energy, and define the differences between active and passive solar technology
- explain how heat is moved by conduction, radiation, and convection, and demonstrate the application of this knowledge
- outline the operation of a solar collector, and specify some residential uses of solar energy
- relate the operation and use of solar photovoltaic cells
- identify the different forms of technology used to generate wind energy, and describe the inherent potential and problems
- distinguish the four different types of biomass, and summarize how biomass can be used as an energy resource (especially wood)
- discuss the importance of hydroelectric energy, and identify and describe one example in Nova Scotia
- relate the application of an alternative source of energy

CONTENT

Energy

Basic forms
- chemical
- electrical
- mechanical
- thermal
- nuclear
- light

- two types:
    - potential
    - kinetic
- measuring and conversion
- control, storage, and conservation
- supply and demand
- common sources
- resources

Fossil Fuel, Solar, and Nuclear

- Coal, petroleum, natural gas
- Solar principles
- Solar systems
- Production and use
- Nuclear fission

Alternative Sources of Energy

- Cogeneration
- Small/local sources
- Networking

SAMPLE ACTIVITIES

Have students:

- conduct a survey of the major types of fossil fuels used in the local community

- investigate the forms of energy used in the local community

- provide examples of how energy is transferred by conduction, convection, and radiation

- do a home audit to find out the demand sectors for energy under the headings: space heating, water heating, cooking, clothes drying, refrigeration, air conditioning, appliances, computer operations, and lighting

- make recommendations for improvements that can be made to reduce energy consumption

- select a common product such as an automobile or a computer and identify the parts that need energy for operation

- construct a model of a solar collector and measure and test its efficiency

- investigate the advantages and disadvantages of solar-powered vehicles and prepare a report

- design an experiment to determine the materials that are best for storing solar energy

- make comparisons between the difference in solar energy exposure of windows facing south and windows facing north

- participate in a debate about the pros and cons of nuclear energy

- investigate near accidents that have taken place at nuclear power stations in Canada, the United States, and around the world

- investigate the cause of the disaster that took place at Chernobyl in the former Soviet Union

- design a chart that outlines examples of everyday use of different forms of energy such as chemical, heat, light, sound, electrical, mechanical, and nuclear

- do a survey of how products used in a "student's world" can be redesigned to help to conserve energy

- develop flow diagrams to illustrate energy transfer for simple products used around the home, such as hair dryer, snow thrower, electric blanket

- using salvaged materials or a construction kit, design and develop a model of a machine that can harness alternative energy sources, such as wave, tide, wind, or solar to do useful work

- design an interior heat reflector for use in an automobile for the front, side, or rear windows

- design, build, and construct a device that converts potential energy into kenetic energy

- design, construct, and demonstrate a device that changes organic waste into usable energy form

- participate in the Alternative Energy TLA

UNIT 5–POWER GENERATION, TRANSFER, CONTROL AND CONSERVATION

OUTCOMES

Students should be able to:

- describe how Nova Scotians produce power from the three basic energy source groups
- describe and provide examples of energy conversion for the purpose of moving energy to where it is needed, and delivering it in a form appropriate to the need
- explain how to apply the basic elements of control to various energy or power forms-stop, start, amplify, efficiency, containment and direction
- describe the operation of hydraulic and pneumatic fluid power systems, and explain fluid power principles, including force pressure and mechanical advantage
- define various fluid characteristics, including viscosity, pour point, and types of additives, and compare and contrast the advantages and disadvantages of using synthetic fluids in fluid power systems
- realize the importance of lubrication in reducing energy losses
- realize in products that parts can move in relation to one another and that such systems are called mechanisms
- use calculations to predict the operation and effectiveness of mechanisms
- associate that control systems have inputs processes and outputs, and locate these in products
- understand that sensitivity and lag are important in control systems
- specify boundaries within a control system to clarify where the system to be controlled begins and ends
- identify within the construction of a product the difference between an open and closed loop system, and the importance of feedback and achieving control
- pinpoint and record the control functions of various parts of a system that have been produced
- design and model simple mechanical systems that change the magnitude and motion of an input force in terms of type, axis, or plane
- demonstrate how fluid is used to transfer force and can be used to change the relationship between force distance or speed
- define and apply several terms used to describe power, including work, power, force, torque, and horsepower, and describe how horsepower is measured
- use different sources of energy in products that have been made to control movement in devices that are being made, and recognize that control is making things do what is intended
- embody in a product design: levers to augment movement, gears or pulleys to change the speed and direction of rotation, or electric circuits twinned to a power source

- operate and combine simple mechanical components such as linkages, cranks and gears to achieve different types of movement, e.g. linear, rotary, or oscillating, within a product

- interconnect different systems in a product using solenoid or electro-mechanical interfaces

- employ sensors in switching and digital logic circuits

- use different sized and/or linked syringes to transmit force pneumatically or hydraulically

- apply a range of valves and other control devices and make analogies with switching devices, and other systems

- employ mechanisms to achieve movement in more than one plane

- use single-acting cylinders in three port valves in basic pneumatic systems

- actuate mechanisms to achieve movement in more than one plane

- employ micro electronic devices to control pneumatic, hydraulic, or mechanical systems

CONTENT

Mechanism Model and Control

- base plate and beams
- axles, pulleys and propellers
- electric motor and leads
- switch, sensors, and transducers
- command control and programs
- writing procedures
- saving work
- loading and setup
- testing

Fluid Power

- The science of fluid power
  - Bernoulli's Principle
  - Pascal's Law
  - Boyle's Law
  - Charles Law
  - force/pressure/area
  - relationships
- Fluid power systems
  - hydraulic system
  - pneumatic system
- Fluids–storage and filtration
  - reservoirs
  - filters/strainers/dryers
- Pumps and compressors
  - piston pump
  - vane pump
  - gear pump
  - continuous flow compressor
  - positive displacement compressor
- Control valves
  - on/off valves
  - directional control
- Valve
  - three way/four way
  - pressure relief
  - check
- Conductors and connectors
- Actuators
  - cylinders
  - motors
- Interpretation of fluid system schematics

Some Additional Considerations

If funds permit purchasing materials for either pneumatics or hydraulics, you may find these points helpful.

- Pneumatics may be considered less hazardous than hydraulics due to lower pressures involved. In either case, proper instruction and attention to safety should be a prime consideration.

- In any design of a fluid power system, all components should be assembled with quick disconnect couplings.

- Where noise could be a factor, hydraulic systems may have an advantage.

UNIT 6–ENVIRONMENTAL IMPACT OF ENERGY, POWER, AND TRANSPORTATION

OUTCOMES

Students should be able to:

- explain the coal mining process, and appreciate the possible negative and positive impacts on society and the environment

- express the major principles of how to conserve energy in any system, including heat loss, gain, and other thermal properties

- provide examples of methods used to save energy in the commercial and residential sectors of society, and identify the use of several energy-saving appliances

- specify and communicate several ways to save energy in the transportation sector of society

- observe how the use of power contributes to pollution, and list the major sources of pollution

- discuss the role of government in controlling pollution, and explain the importance of recycling

- discern and describe the possible technologies that may evolve in the future in the area of energy, power, and transportation

- recognize the need and purpose for space transportation programs

CONTENT

- needs–energy requirements and conservation
- home and local strategies
- national and local strategies
- the future
- social and individual impacts
- impacts on land, lakes, rivers and bodies of salt water

SAMPLE ACTIVITIES

- develop a positive and negative chart for the use of coal, oil, and nuclear fuel

- develop a thesis to support one of the following alternative energy sources: sun, wind, wave, and tides or earth's core

- investigate alternative energy storage units, such as batteries, fly wheels, hydrogen gas, and water storage

- investigate a hydroelectric energy project in Nova Scotia or in Canada

- do a survey to discover which energy sources cause most damage to the environment and which of the three fossil fuels pollutes the least

- generate a strategy for encouraging recycling in the school, home, or community

- record the waste produced in a home situation by weight for 7 days, and then, using a computer program, produce a bar graph to illustrate the results

UNIT 7–FUTURE TRENDS AND CAREERS

OUTCOMES

Students should be able to:

- outline and describe current and potential careers in transportation and power technology
- explain the role of research and development in gaining new knowledge and solutions to problems in the realm of energy, power, and transportation
- summarize how an understanding of their personal abilities, interests, and values, is important in making a career choice

CONTENT

Future Trends

- forecasting needs
- research and development
- storing and using energy
- lasers
- cryogenics
- superconductors
- fuel cells
- magnetic levitation
- other developments

Careers

- career opportunities
- programmer
- engineer
- designer
- technician- instructor
- career searches
- personal knowledge
- abilities
- interests
- aptitudes
- decision making

SAMPLE ACTIVITIES

Have students:

- use a word processing or a desktop publishing program to design a chart listing the correct avenues prevalent in the energy, power, and transportation areas and list the pertinent interests and aptitudes
- participate in the A Train TLA
- participate in the Flight Simulator TLA
- make a graph to rate the elements used to identify attitude, e.g., promptness, attendance, cooperation, reliability, persistence, patience, and self-awareness

TLA # 1 SMALL ENGINE TECHNOLOGY

INTRODUCTION

In the early 1950s mass migration to new homes in urban and suburban areas, as well as the growth of leisure time activities, led to an increased demand for the work and time-saving advantages of small internal combustion engines. These machines, of various capacity ratings, are now produced by the millions. Engine-powered products are common household items in every community. There are more air cooled engines than automobiles produced annually in North America. Most of these engines power a variety of outdoor equipment, including mowers, tillers, and tractors, and millions more operate pumps, generators, small construction equipment, log splitters, refrigeration units, and snow-throwers - almost anything requiring portable power.

In 1990 the US Environmental Protection Agency enacted limits on emissions produced by off-road equipment, which are to be implemented in 1996 and 1999. These will drastically change small engine design, and some of the innovative features may include:

- overhead valve design
- cast-iron cylinders plated with nickel silicon
- hydraulic valve lifters
- v-block design with two cylinders
- 9:1 compression ratio
- 15A changing system
- 12 v starter system
- pressure lubrication with oil filter
- air or liquid cooling option
- oxygen sensor in exhaust stream
- electronic fuel injection
- computer-controlled fuel/air mixture
- catalytic converter/muffler

The changes in small engine technology listed above will close the gap between air-cooled engines and automotive engines.

OUTCOMES

Students should be able to:

- describe basic engine construction and explain the principles of operation of the internal combustion engine
- identify two-cycle and four-cycle internal combustion engines
- demonstrate a working knowledge of the following internal combustion engine systems: fuel, ignition and starting, lubrication, cooling, and electrical
- calculate, the size, capacity, and output of power-producing engines
- troubleshoot, service, and maintain a variety of internal combustion engines related to the student's particular needs, interests, and abilities

TERMINOLOGY

bore	housing
camshaft	hydrostatic fluid
carbon monoxide	ignition
carburetor	muffler
choke	piston
clutch	reservoir
connecting rod	retainer
crankcase	sparkplug
cycle theory	stroke
cylinder block	throttle
displacement	transmission
flammable	valve lifter
gasket	valve magneto

PROCEDURE

Small Engine Procedure:

1. Drain the oil and the fuel from the engine.

2. Using appropriate tools, disassemble the engine external parts. Consult the engine manual. Design a checkoff procedure to catalogue all components.

3. After the crankcase has been exposed notice the crankshaft-to-camshaft markings. These two gears must be timed correctly; look for marks on the teeth of the gears. Check the maintenance manual to determine exactly what to observe.

4. Remove the piston and connecting rod, noting its position relative to the block at the engine. Also note the rod end cap markings if visible.

5. Remove the crankshaft from the engine.

6. Clean all parts in the solvent liquid.

7. Locate the specification listing in the small engine manual and measure the part using the correct measuring tools.

8. Begin engine assembly and make sure all nuts and bolts are torqued to manufacturer's specifications.

9. Install the crankshaft back into the engine and install piston connecting rod and cam gear and ensure that the cam gear is correctly timed to the cam-shaft.

10. Finish assembling all parts of the engine and check the end play of the cam-shaft according to the manufacturers specifications.

11. Complete engine assembly and test.

BACKGROUND INFORMATION

The following is an outline of the education program offered by Briggs & Stratton Canada Ltd.

Who Qualifies?

The program offered by Briggs & Stratton is intended for use by schools with grades 7 through 12 and by vocational schools and colleges. Other non-profit schools and organizations will be considered for eligibility on an individual basis.

To participate, a school must meet ***all*** of the following conditions:

1. The school must have an ongoing course in air-cooled gasoline engine theory and/or repair. The course must either be a stand-alone course or part of a broader curriculum in which air-cooled engine operation and servicing is a major component of the program of study.

2. The materials supplied are the exclusive property of the school for classroom use only.

3. The school must welcome any visitation by Briggs & Stratton Corporation representatives wishing to review the use of this material.

4. The school must agree that the educational aids offered by Briggs & Stratton are a gift to the school and are not to be considered "belonging" to any individual teacher.

For further information and assistance in developing a program, contact the Briggs & Stratton Central Service Distributor:

Briggs & Stratton Ltd.
301 Ambassador Drive
Mississauga, ON L5T 2J3

Upon approval, the following materials will be forwarded to the school:

1. One engine of Briggs & Stratton's choice. Reasonable requests for a specific type of engine will be considered; however, this could entail a delay in delivery to the school.

2. A quantity of repair instruction manuals and *General Theories of Operation* booklets to serve one class. If there are several classes during one semester, the actual number supplied will be determined by the largest class.

3. A set of turn-over charts showing selected illustrations found in the *General Theories of Operation* booklet.

Renewal:
After three years, the above material can be renewed in quantities based on the class size at that time, however, the school must reapply. The renewal is not automatic. If a teacher is uncertain as to whether the school is eligible Briggs & Stratton should be contacted.

TLA # 2 THE AUTOMOBILE

INTRODUCTION

The first known horseless carriage was conceived and built as a wind power machine in the early 1400s. A Frenchman, Nicolas Joseph Cugnot, built and operated a steam-powered automobile in 1770. The word automobile was developed in France and derived from the Greek word "auto" meaning self and the French word "mobile" meaning moving. During 1885 Gottlieb Daimler and Carl Benz built successful gasoline engines similar to the type used today. In the United States, William Morrison built an electrically powered car in 1980, and in 1896 Henry Ford developed a gasoline-powered automobile and produced the model T Ford in 1908. The Model T could be assembled on an assembly line in only 93 minutes and sold for around $290. The car was available in only one colour, black. This was the first-mass produced automobile; it was reliable and easy to repair, and over 15 million were built during a 19-year period. The rapid development of the automobile had a significant effect on people's lives, their communities, and the environment. In 1984, 130 million automobiles were registered in the United States, 27 million were registered in Japan, and 14 million were registered in California.

A typical automobile consists of 783 kg (1,728 lbs) of steel, 212 kg (468 lbs) of iron, 96 kg (212 lbs) of plastic, 83 kg (184 lbs) of fluid, 62.5 kg (138 lbs) of aluminum, 16 kg (36 lbs) of rubber, 38.5 kg (85 lbs) of glass, 13 kg (28 lbs) of copper, 11 kg (24 lbs) of lead, 8 kg (18 lbs) of zinc, and 76 kg (167 lbs) of other materials for a total weight of 1446 kg (3,188 lbs).

OUTCOMES

Students should be able to:

- recount aspects of the development of the automobile and various automotive information
- identify the major automotive systems and recognize the operation of features in both profile and plan view
- illustrate the basic principles of the operation of the following:
  - differential
  - air-bag
  - front wheel drive
  - manual transmission
  - interior system
  - suspension
  - engine
  - ignition
- save and import an image from Autoworks to a desktop publishing program for illustration purposes
- experience the Autoworks simulation activity in the quiz and test mode

Terminology

air dam
brake drum
bell housing
cylinder
caliper
carburetor
catalytic convertor
clutch differential
coil
distributor
exhaust manifold fan
exhaust port
rack and pinion
rotor master
shock absorber
supercharger
thermostat

transmission
turbo charger
voltage regulator

PROCEDURE

(Using *Autoworks* software program, published by Software Marketing Corporation)

Have students:

- View the four main components: the image view window, the tag list, the menu bar, and the icon buttons. All of these work together to present information and control the session. The tag list displays items relating to the current image - more in-depth information about an item can be selected by choosing an individual button from the list on the right of the screen.
- View the associated text under the tag list, by double clicking on the tag
- View the major automotive systems in both profile and overhead view
- View the major system in images by clicking on the zoom in button, and again access the appropriate text in relation to the tag list that appears
- Use the icon buttons under the various systems:
  - engine
  - transmission
  - suspension
  - exhaust
  - fuel
  - AC and heat
  - brake
  - electrical
- Use the zoom-in function and use the scroll bars and then use the zoom-out function
- Use the bookmarks, which can be placed to facilitate moving back to a position saved in an earlier session
- Actuate the backup button, which facilitates back-tracking through earlier views
- Use the see also button, which provides a list of items related to the current image
- Run through the index search, which facilitates finding items to be indexed, by typing the appropriate word in the search box
- Export an image from *Autoworks* to another software package such as a paint program or a desktop publishing program (for example to illustrate a research project or report). These should be saved as a PCX file
- Perform the *Autoworks* simulation game in both the quiz and test modes
- Save and print images from the *Autoworks* program.

RELATED ACTIVITIES

- Investigate the following races which take place in Nova Scotia, British Formula 2 series, Formula 1600 series, GM Good Wrench Service Plus MASCAR, Motorcycle Formula One and Two, and Grand Touring GT1, GT2, and GT3

- Inquire about the truck driving championship arranged every year by the Atlantic Provinces Trucking Association. Drivers from the Atlantic region compete in several categories:
  - five axle class
  - four axle class
  - straight truck

- Investigate the new technologies being built into contemporary trucks, especially the ones that are computer related, such as satellite tracking systems.

- Explore the linked menus and systems of the *Autoworks* program as follows:
  - View engine and identify:
  - the air intake
  - engine block
  - exhaust manifold
  - fan
  - front transmission
  - piston configure
  - super charger
  - transmission
  - turbo charger

- Under the engine block identify:
  - alternator belt
  - carburetor
  - distributor cap
  - oil dip stick
  - oil pan
  - stator
  - valve cover
  - water pump

- Under alternator identify:
  - armature
  - brushes
  - drive pulley
  - electron magnet
  - front bearing
  - pulley fan
  - rear bearing
  - rotor winding
  - slip rings
  - starter coil
  - stator core

- Under drive pulley identify:
  - the pulley / power drive gear etc.

- Continue viewing these linked menus and view and read the associated text to develop an understanding of the operation and interrelated nature of the components of the different systems.

- This procedure should be used for the other systems :
  - transmission
  - suspension
  - chassis
  - exhaust
  - cooling
  - AC and heat
  - brakes
  - electrical.

Also zoom in and out and view the full screen option when appropriate

BACKGROUND INFORMATION

Some highlights of recent developments :

- 1948 Michelin releases the radial tire and Goodyear introduces tubeless tires

- 1950 disc brakes introduced by Dunlop

- 1951 power steering introduced by Chrysler and Buick

- 1954 fuel injection introduced by Bosch

- 1970 land speed record of 1000 kmph (622mph) by American Gary Gabelich

- 1972 Dunlop develops safety tyres that seal after a puncture

- 1979 Budweiser Rocket reaches 1189 kmph (739 mph)

- 1980 Audi introduces a four wheel drive car

- 1981 BMW introduces the first onboard computer

- 1987 Sun Racer travels from Darwin to Adelaide, Australia, in six days powered by the sun

RACING AND SPEEDWAYS

In 1906 a track was built in Brooklands, England. The track was a 4.45 km circuit that was 30 metres wide and had two curves banked to a height of 8.5 metres. This track was the first speed track built especially for racing and was used for sprint, relay and endurance, handicap, and long distance races. Other early oval speedways included Monsa, Milan (1921), and Montlheray, Paris, (1922). One of the best-known speedways is Speedway Illinois near Indianapolis.

GASOLINE ENGINES

The gasoline engine is usually defined as any class of internal combustion engine that generates power by burning a volatile liquid fuel with ignition initiated by an electric spark. The most widely used engine is the gasoline engine. Gasoline engines vary in size and power; some of the smallest engines are used in models and generate less than one horsepower while some full size gasoline engines generate as much as 35,000 horsepower. The principal means of operation of most gasoline engines is the reciprocating piston. The reciprocating piston engine can be subdivided into two categories: two stroke and four-stroke. The four-stroke automobile engine is the most common. The principle for the four-stroke gasoline engine is attributed to the French engineer Alphonse Beau de Roschas in 1862. The prototype of the modern automobile was developed in 1876 by the German engineer Nikolaus Otto.

Some International Registration
Afghanistan AFG
Australia AUS
Bahamas BS
Bangladesh BD
Burma BRU
Canada CDN
Czechoslovakia CS
Denmark DK
Ecuador EC
Egypt ET
Fiji FJI
Finland SF
Great Britain GB
Guatemala GCA
Hong Kong HK
India IND
Iraq IRQ
Ireland IRL
Kenya EAK
Madagascar RM
Mauritania RIM
Netherlands NL
New Zealand NZ
Pakistan PAK
Poland PL
Seychelles SY
Switzerland CH
Trinidad and Tobago TT
Israel IL
Zimbabwe ZW

REFERENCE

Autoworks - Software Marketing Corporation
9830 S 51st Street, A-131
Phoenix AZ 85044
Tel: (602)-893-3377

TLA # 3 - A-TRAIN

INTRODUCTION

(*A-Train* was created in Japan by ARTDINK and was originally released as *Take the A-Train 3,* in Japan April 1986 for the Fujitsu FM series computer. *A-Train* was released in Japan in 1988.)

"Hear that lonesome
whippoorwill,
He sound too blue to fly
The midnight train is whining
low, I'm so lonesome I could cry"
Hank Williams

RAILWAYS IN CANADA AND THE WORLD

The railways role in the development of Canada was crucial. Not only was the railway the lifeline that joined the whole of Canada together, but it soon became the lifeline of commerce. In the early days steam locomotives were dominant. They were monumental engineering works with powerful engines and supporting observation cars, which allowed the traveller to see the vast expanse of the Canadian landscape.

In the early days, the railway could not have been possible without the backbreaking labour of immigrants from many countries. Through this achievement a complex web of commerce gradually spread out across the country, providing a valuable lifeline between western Canada, central Canada, and the Maritimes.

The steam engine continued to be a formidable presence across the country into the 20th century, diesel locomotives started to replace them. General Electric produced some of the first commercial locomotive diesels, which were connected to direct current electrical generators supplying power to traction motors that moved the vehicles. The Electric Motor Company, a division of General Motors, standardized many aspects of diesel locomotive designs in the late 1930s and later began to produce general purpose locomotives that could do yard and road duty as well as various classes of service. Diesels were more efficient, operated better under fierce cold, required less maintenance, and were more economical than steam. During a few short years therefore in the 1940s and 1950s, railways were transformed from steam to diesel. Road and air transport started to compete with both freight and passenger service, which eventually spurred the railroads to attempt some new solutions. For one example, in 1977 the Canadian government established Via Rail Canada to run the passenger service that was previously operated by both Canadian National and Canadian Pacific.

With the development of large cities and increased population railways have continued to expand. For example, London, England, has a vast underground rail system where headway between trains can be as little as 90 seconds (at one complex junction 1,200 trains pass through at peak hour).

Washington, DC, metro is now the most automatic subway in the United States and is completely coordinated with bus and rail routes. It uses automatic fare collection, track geometry cars, and ultrasonic rail testing for precise track maintenance with devices so sensitive to changing conditions that cars can run virtually without operators.

Communities all over the world have invested in subway and light rail systems with varying degrees of success, e.g., London, Paris, Tokyo, Moscow, and Montreal. Bombardier of Quebec has played an important role in some of these systems. Vancouver has a 21.8 km/h sky train which is North American's first fully automated transit system carrying 60,000 passenger daily. Automated guide way transit systems are in operation in Japan, France, and Miami, with others in the conceptual stage of development.

In Japan the incredibly population density of the Tokyo-Osaka corridor has spurred the design of a wider and safer gauge, and trains with a sleek distinctive nose called bullet trains. The system premiered in 1964, offering regular 201 km service. The bullet trains have automatic speed and braking control, and new designs are being developed including double deckers, which will travel at a top speed of 297 km/h. Fast speed trains have also been developed in other countries. An example is France with the TGV (Train à Grande Vitesse) for its Paris-to-Lyon route. The TGV carries 5.6 million passengers a year at an average speed of 51 km/h and has automated signalling and electronic track sensors, which evaluate the speed, course, and conditions of the train. It is hoped to develop a core network of TGV trains over much of northern Europe. Rail transportation is also a major feature of the Channel tunnel, which links London and Paris in two hours.

TERMINOLOGY

assets
balance sheet
business fluctuations
cargo
commercial
district development
expenditures
growth chart
lease
map territory
menu
multi-city connection
reconstruction
revenue view
rolling stock
satellite
schedule
scroll
subsidiaries
subsidiaries information
train registry

OUTCOMES

Students will be able to:

- simulate the relationship between transportation, business, and city development
- design and manage an efficient and profitable transportation system for both passengers and freight
- simulate, influence, and control the growth of a city by: investing in land and building offices, apartments, hotels, factories, golf courses, amusement parks, stadiums, ski resorts, etc
- simulate the financing of the development

PROCEDURE FOR A-TRAIN SOFTWARE

1. Under the systems menu, select "new" and load scenario number l. A map of the railway operation will be provided, surrounded by a picture frame and menu choices. A running clock in the upper right hand corner indicates the fiscal term from April 1 to the present. Passing of time is illustrated by changing patterns of light as day fades and night falls (VGA monitors only). Seasonal changes also appear as the simulation progresses. The scenario map is one of the most open and underdeveloped of the six scenarios, which provides for substantial experimentation and risk. The scroll key can be used to get a feel of the

territory, north, south, east and west. It is also possible to use the whole picture to the overall map boundary by clicking on the satellite, which will display a small image of the complete map.

2. The position of hills, rivers, and lakes should be noted as they play a significant part in the railway setup. Note that a freight and passenger train are already in operation on established lines. The freight train returns from excursions laden with materials, which are deposited in a large pile at the station. If the storage place is full, it will pick up materials to be sorted outside. These are the construction materials, which will be used for commercial properties and other holdings as they are developed. Their placement and train transport play an integral part in the city development.

3. Click on "report 4" - the urban growth chart - and take note of the statistics of the city status, particularly the population total.

4. Next, scroll to an underdeveloped area of the map and open the "trains" menu and start to lay track. This can be done by dragging the mouse in any direction. Practise laying and removing track and note that the figure in the cost box will change with each block of track laid. This number reflects the purchase price of the land and the track laying and removal charges. Practice will also be required for laying curved track. When laying track, adjustments will have to be made for geography. (Dual track can be laid if desired.)

5. Thought should be given to organizing the railway, such as buying and placing first stations and arranging trains. To do this, exit the "lay track" menu and click the "buy train" command and the "train" menu. A rolling stock market will be displayed followed by the available train models and a chart detailing the statistics of the chosen train. The train registry shows what trains are already in operation. When a train is selected, a larger picture of the train will appear at the bottom, along with the vital statistics, model types, capacity, cost, etc. (See list of sample trains at the end of this TLA.)

6. A good idea would be to start with a cheap freight train, then exit and click the "place train" command from the "trains" menu and place the train on the track. Continue by building and laying stations. Start small at first, and make an area adjacent to the station for material storage (by purchasing land around the station and using the "subsidiaries menu" and clicking on "real estate.")

7. Another station can be placed at the other end of the line. Using the switches and scheduling menus, start to build up competence as a switch master and a scheduler to move freight to the required location, for example, one of the stations where land was purchased.

8. Construction materials are a resource from which buildings are constructed. When a store of materials has been built, property development can be started under the "subsidiaries" menu, e.g., factory, commercial, hotel, golf courses, amusements, ski resorts, stadium.

9. Apartments can be built near the station, which will attract population, who in turn will need a place to work.

10. Constant speculation of subsidiaries will eventually result in a no buyers message, and the report card will have to be evaluated. As things develop, faster trains will be required, and also the intricacies of scheduling will need to be explored. Some trains may have to be removed or set to different directions so that schedules can be synchronized to avoid accidents. Profits can be increased by: increasing track and land; adding other stations; by changing around commercial development. The report card will give a report on profit and loss as well as the bottom line and will have to be studied regularly.

Note: The first level of the report shows cash on hand, total debt, and estimated taxes. The next level displays the first figures and constantly updated rail sales and subsidiaries income numbers for the day, month, and fiscal term. Fees are calculated on the screen as well as the profit loss figures for those times. These costs include initial train purchases and initial track laying costs. The next level provides details on stations, switch cars, and track rentals as well as a graph showing money. The aim is to keep the money lines as healthy a black colour as possible.

Report card 2 reflects overall holdings, rail subsidiary stocks, and real estate It provides values of these properties and their associated taxes. There is also a revenue column for all these holdings that includes market dividends and taxes on all incomes, as well as expenditures for all holdings, including commission paid on real estate deals and interest on loans.

Report card 3 provides information on cash on hand and all of the commercial properties.

BACKGROUND INFORMATION

With automobile congestion becoming a greater problem, alternative transportation systems will have to be developed. Railway type systems, either on the ground or underground or above ground, will provide many of the solutions. In transportation technology, traffic engineers are designing intelligent vehicle highway systems, in which sensors embedded in highways and cars relay critical up-to-the-moment traffic information to drivers to enable them to avoid congestion. These smart highways are being introduced in Europe and Japan. Other research is progressing to investigate on-board car computers to control speed and braking and to sense obstacles ahead. These would allow cars to travel close together safety on highways, tripling carrying capacities.

Changes are usually evolutionary rather than revolutionary, and transportation planning cannot be separated from urban land-use planning. Comprehensive strategies will have to be developed to coordinate and integrate within the overall context.

SAMPLE TRAINS

- KIHA40 - diesel passenger train using a local line in cold places
- 415 - a commuter train with a stainless steel body more suitable for suburban travel
- 381 - super express passenger train designed especially for running on curved lines
- 113 - a direct current electric train using suburban lines running by the sea
- KIN30,000 - a super passenger express train with a double deck

Reference: *A-Train* Maxis
Two Theatre Square, Suite 230
Orinda, CA 94563-3346.

RELATED ACTIVITIES

Have students:

- research the definition of intermodal conveyance as applied to transportation in Canada (i.e., how CN and CP Rail have improved tunnel clearances to handle double-stack trains for carrying containers coast to coast).

- Investigate the repercussions of the completion of Canadian National's Sarnia/ Port Huron tunnel which will accommodate double stack rail cars, especially for the Port of Halifax.

TLA # 4 - FLIGHT SIMULATION

AIM

Students will experience flight simulation in real time by using a flight simulation computer software program, which involves a three-dimensional dynamic display, including flight control instrumentation, minimum Visual Flight Rule (VFR), and Instrument Flight Rules (IFR) Instrumentation.

INTRODUCTION

Computer simulations are an important aspect of orientation and even training in some careers. A computer flight simulator features detailed graphics that closely simulate the pilot's actual perspective. With the latest in high-precision graphic drivers, flight simulators present solid model images with hidden surface elimination, surface shading, and considerable accuracy. Flight simulators can also simulate different types of aircraft, such as single engine, high performance propeller-driven aircraft and business jets.

OUTCOMES

Using a flight simulator and display, students should be able to:

- demonstrate a knowledge of the basic aircraft controls instrument and flight systems
- demonstrate an understanding of the primary aircraft controls including control yoke and rudders, throttle, and brakes
- demonstrate an understanding of the secondary aircraft controls including flaps, elevator trim, carburetor heat, magneto switch, mixture fuel control, lights, strobe, and landing gear
- demonstrate a knowledge of aircraft radio operation including VOR navigation radios (NAV 1 and NAV 2) and the Omni-Bearing Indicator (OB1), and demonstrate flight instrument calibration
- demonstrate the basic procedures of flying a single engine aircraft, including how to taxi, take off, climb, turn, and land
- demonstrate the basic procedures of flying a business jet, including specific flight techniques
- demonstrate a knowledge of the environmental factors that affect the control of aircraft, such as flying in different seasons, and, different weather conditions, for example, in clouds, thunderstorms, and turbulence
- know how to keep track of flight hours by recording them in a log book or pilot log and how to make log book entries
- know how to conduct basic flight manoeuvres such as taxiing, attitude flying, straight and level climbs, cruise descents, slow descents, final approach flare, and touch down

TERMINOLOGY

aileron,
air traffic control (ATC)
airfoil
air speed
altimeter
altitude
atmospheric pressure
attitude flying
auto pilot
barometric pressure
calibrating
control yoke coordinates
dihedral
elevator

fuselage
instrument
flight rules (IFR)
lateral access magnetic compass
Omni-Bearing selector
radial
recovery
rudder pedal
simulation stall
taxiing
thrust
transponder
turbulence
visual flight rules (VFR)
yaw
yoke

PROCEDURE

Have students:

- Go through the procedures of the first flight routine, including starting the flight simulator

- Observe and identify the parts of the air plane, including the right aileron, the flaps, the horizontal stabilizer, trim flaps, rudder elevators, left aileron, left wing, fuselage, nose wheel and landing gear, and right wing, as well as the purpose of the control yoke and rudder, the elevators, the throttle, and the brakes

- Practise how to adjust the flaps with the keyboard or the mouse

- Control the elevator trim with the keyboard

- Go through the basics of flight for the single engine aircraft, as well as, the business jet, including the procedures that give a gradual introduction to the aircraft. This should include how to check instruments, take off, climb, turn, and land the aircraft.

BACKGROUND INFORMATION

The single engine aircraft used in the flight simulator software program is closely patterned after a Cessna Turbo Skyplane RG11 (basically a 182 with retractable landing gear, turbo charged engine, and other performance modifications). The jet used in the simulation is based on the Gates Lear Jet 25G twin turbojet aircraft, which has a maximum takeoff weight of 7393 kg (16,300 lbs). This weight is greater than the Cessna turbo skyplane weight of 1406 kg (3,100lbs.). Therefore it takes a lot of effort to slow down or change the direction of flight of this aircraft, especially on landings. The Lear jet is a streamlined plane, and the two General Electric CJ610-8A turbojets are powerful engines. The biggest problem with this plane is running into too much speed; Ma/h .82 is a maximum operating speed. The over speed danger cannot be overemphasized. This plane is so powerful that it can easily exceed Mmo, in level flight with full throttle. If there is too much Mmo supersonic shock waves travel back on the wings until they reach the ailerons. Since the aircraft uses mechanical linkage controls, the yoke begins to buzz, and snatches widely from side to side, which in turn can lead to an out-of-control condition.

The flight simulator world spans more than 100 million square miles, encompassing the continental United States and extending into Canada, Mexico, and the Caribbean. A second coordinate system allows the world to extend into Europe and South East Asia. Because flight simulators are real time simulators, flying between distant points such as Halifax and Calgary can take a considerable amount of time, and therefore short distances are preferred for simulation.

RELATED ACTIVITIES

- Investigate the engine room trainer currently being installed at the NS Community College Nautical Institute campus at Port Hawkesbury. The simulator is a modular, dynamic, real time computerized trainer, which makes it possible to compress scenarios encountered through years of sea experience into a few weeks.

- Contact Air Nova, who have installed an access lift that allows disabled air travellers safe and dignified boarding and deplaning access to commuter and small jet aircraft.

- Contact Air Nova to compile a list of aircraft that are to be specifically dedicated to different destinations such as the Dash8 named *City of Sydney*.

TLA #5 - COMPUTER CONTROL LAB: MOTORIZED VEHICLE AND DYNAMOMETER

INTRODUCTION

Transportation technology moves people and products from one point to another and can involve vehicles moving on land, in water, or in space. Vehicles are an important mode of transportation, and the speed a vehicle travels is important to facilitate transportation. A speedometer is an instrument used by most vehicles to measure the speed achieved by the vehicle. Lights are an important feature of transportation vehicles and are crucial for night operation. Lights need to be positioned correctly, and the intensity of light for optimum performance can usually be adjusted. A dynamometer is a test instrument used to hold a vehicle stationary, while individual parts are inspected by a computer and the performance is analysed. The dynamometer facilitates the running of the vehicle motor so that the vehicle wheels rotate, and the speed of rotation can be measured.

OUTCOMES

Students will be able to:

- define how distance and speed can be measured and how light intensity can be measured
- use software tools and commands to design and develop a control panel for the operation of a model dynamometer
- interpret the feedback from sensors to monitor the vehicle speed and headlight alignment of a vehicle
- use a computer control lab to measure revolutions of a vehicle axle per minute (RPM)

TERMINOLOGY

angle sensor
ASCII
boolean
command component
control and logic input sensors
disc management
graph box
icon
input
input port
interface box
light sensors
list
monitor box slider
motor lamp
output
output port
page element
primitive
reporter
screen management
subprocedure
superprocedure
system generated primitives
temperature
text file
text box
touch sensor

PROCEDURE

Have students:

- Use a construction kit to produce a model vehicle designed to their own specification. The vehicle should have lamps that can be adjusted up and down, and an electric motor to generate power and drive to the vehicle wheels.

- Construct a dynamometer model that incorporates the following:
  - a platform to suspend the vehicle so that it remains stationary as it runs
  - a device to measure the rpm of the axle and tires
  - a device for checking the alignment of the headlights
  - a computer-controlled button to control the operation of the vehicle motor
  - a computer-controlled slider to adjust the power level of the vehicle motor
  - computer-controlled buttons to operate the headlights
  - a computer-controlled slider to adjust the intensity of the headlights

- Connect the lamps, motor light sensors, and angle sensor to the serial interface and position appropriate icons

- Do specific tests on the lamp icons, one at a time, to make sure light icons register the light intensity

- Click on the circles above the motor icon to make sure the vehicle motor rotates the axle and tires

- Calculate the car speed using the dynamometer feedback to compute the rpm of the vehicle tires.

RELATED ACTIVITIES

Have students:

- add mass to the vehicle and measure the effect on the car

- modify the motorized vehicle to include an angle sensor on its back axle, program the vehicle to move a specified distance, and calculate the speed

- compose an advertisement to promote the vehicle's performance

TLA # 6 - ALTERNATIVE ENERGY

INTRODUCTION

The story of civilization has been one of people developing ways of producing power to facilitate survival.

Initially power was produced using muscle, or wind or water, but in recent times many new means, such as steam engines, electric motors, and internal combustion engines, have been developed. As sources of fuel to operate these machines have become depleted, an intense interest has arisen in learning about various ways power can be produced. Therefore, students need to know about these different sources and how they can be developed in practical, small-scale ways.

With the depletion in resources, interest in conserving both fuel and energy has developed. Therefore students need to know the importance of conserving and using energy wisely.

OUTCOMES

Students should be able to:

- use solar energy to provide heating, cooling, and electricity, and display this knowledge by developing a variety of working models and/or projects

OR

- explain the use of wind power as a practical source of energy, and demonstrate this knowledge by producing plans, models, prototypes of a wind-power generating unit

OR

- explain the potential of producing power from the movement of water and be involved in producing plans and either a scale or a full-size model of a hydro-power project

OR

- recount the theory and practice of atomic energy, and display this knowledge by producing a written report on the pros and cons of nuclear power and its implications for the future

OR

- conduct research into underdeveloped methods of producing power (e.g., steam engines, methane gas, sterling engine) and produce a report or a scale or full-size working model of at least one of these engines

OR

- study contemporary and space age power developments, including jet engines and rocket engines, and produce scale models to demonstrate this knowledge;

OR

- demonstrate a sound understanding of the problems associated with ensuring the adequate supply and responsible use of energy in the foreseeable future.

TERMINOLOGY

alternator
dynamo
earth shelter
overshot/undershot
passive/active design
photovoltaics
sluice
trombe

PROCEDURE

Two ways of developing a theme to meet one or more of the outcomes listed above could be done as follows:

Example 1 - Alternative Energy for the Homeowner

- **Passive design**: solar collection, convection collectors, sun spaces, ventilator towers, cool tubes, [1]trombe walls, distribution, storage, thermal mass, back-up heating systems

- **Active design**:
  - *air type*: collector types, transmission, distribution, storage
  - *water type*: collector types, transmission, distribution, storage, freeze protection
  - *phase change*: collector types, transmission, distribution, storage
  - *active design*: controllers: methods of automatic control, safeguards, backup systems; repair and troubleshooting

- **Earth shelter**: basic types, insulation, waterproofing, construction techniques and materials, heat distribution

- **Wood heating**:
  - *cutting and felling trees*: splitting, seasoning, storage, heat valves for different types of chain saw maintenance, safety equipment;
  - *stoves:* types, materials (stone, steel, cast), airtightness, draft control, maintenance, repair, cleaning, fire prevention, water heating;
  - *furnaces:* hot air, hot water, combination types

- **Portable heaters**: kerosene, electric, gas

- **Wind energy**: types of propellers, types of generators, electrical control systems, storage, wind protection, towers and locations

- **Photo voltaics:** structure, uses, installations

- **Water power**: harnessing streams, ponds, sluices, raceway, turbine types, water wheels, ram pumps

- **Cost comparisons**: for various alternate energy techniques involving models or full size prototypes

Example 2: The Water Wheel

The following is an example from a class project. The plan was developed using materials from an alternative energy program. The students had a good general background. We referred to notes and reference texts for specific facts.

The water wheel concept includes an artificial head, sluiceway, water wheel, drive wheel, dynamo reservoir, and water recovery system.

The wheel combines features of the overshot, undershot, breast and Pelton designs. The rationale behind this was to test the design in all of the possible applications. The buckets are large enough to hold a sufficient volume of water to turn slowly and yet provide power. The buckets were sealed so little leakage can take place, providing the maximum output from the water supply.

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[1] Trombe Walls -named for Dr. Feliz Trombe, one of its developers, this passive heating system features a concrete, stone, or masonry, heat-storage, south wall up to 16 inches thick. It may or may not have glazed window openings in it, but it usually has vents at regular intervals both along the floor and just below the ceiling of each room.

The result of each design application was as follows:

- As a Pelton/undershot wheel, the wheel ran smoothly and quickly under free-running conditions; however, it did not run well under load conditions. Improvement could be made by fitting a sluiceway close to the underside of the turning wheel or by encasing the wheel completely to produce a turbine.
- As a breast wheel, our design was a failure under load conditions. Under free-running conditions, we were able to demonstrate the action of the breast design.
- The overshot application proved the most effective, with the weight of the water combining with the force of its flow to give a smooth running reliable system under load conditions.

The diameter of the wheel was 350 mm. The s ides were made from 3 mm plexiglass. The advantages here were low maintenance, high stability in aquatic conditions and transparency, which allowed close inspection of the system. In addition to being sealed to the bucket ends with "geocel" (a black caulk), bolts were used to provide strength.

The buckets were made from 100 mm PVC drainage pipe cut lengthwise. These were positioned accurately to achieve proper balance.

The wheel turned on a 12 mm shaft to which it was attached. The axle was supported by skateboard (ball) bearings. On either end it was turned to the proper diameter (6 mm) to fit the bearing assembly. The "shoulders" on the shaft at the point of size reduction limited side play. One end of the axle was extended to support the 2 mm x 425 mm birch plywood drive wheel.

The drive wheel lent its mass as a counterweight, which helped to even out the wheel rotation. In the wheel were four polyester discs of various colours, which provided an interesting light pattern as the wheel turned.

The drive wheel rotated the dynamo by direct contact, which seemed to be more efficient than the use of a belt drive.

The dynamo or alternator was a bicycle-operated model. Since the drive mechanism was so small on the armature, it served as a brake on the wheel, and its metal structure applied a great deal of pressure on the wheel. We overcame this problem by making a new drive unit, carefully drilling a donated hockey puck, which was pressed onto the existing metal gear.

The reservoir was made from 20 mm D.F. plywood, waterproofed and painted with marine paint. The exterior was enhanced with stone patterned panels. The size of the reservoir was approximately 1200 x 66 x 1800 mm. The normal reservoir pool was about 100 litres of water. A drain hole was provided at one end. The unit was suited for wave production and a tidal-generating project.

The head and water recovery system consisted of a continuous duty 1/4 horse power electric motor with a 20 mm intake and outlet. The plumbing was copper with a primer plug under the removable section of the mill stream (sluice) and a foot valve on the intake.

The water was piped into the stream, made from patterned plexiglass, thence into the water wheel. At about 1700 rpm the pump circulated about 5 litres per minute, which rotated the water wheel at 42 rpm. This produced 2.4 volts, which lit a penlight bulb behind the rotating drive wheel.

The light was emitted in the varied patterns of the plastic discs.

The upper section of the water wheel represented a hill, illustrating a potential drop. The green plastic covering was translucent and was illuminated by means of a small bulb inside the section.

The project created a lot of interest. It could be placed in a prominent place in the main traffic area of the school for the enjoyment of the school population and visitors.

The project could be further refined by enclosing the turbine using Pelton concept and more buckets of water. This could yield about 6 volts with the same setup.

BACKGROUND INFORMATION

There are many experiments, projects and activities that involve students in the following specific procedures, observing events, recording results, and designing and planning the construction of objects.

EXPERIMENTS

Solar

- how light travels (angles, foci-lenses, reflecting surfaces)
- different materials - how they relate to solar energy absorption
- effects of colour and finish as they relate to solar energy absorption
- determining the efficiency of a solar collector
- effects of the number of glazing layers on a solar collector
- solar cooling (evaporation, convection)

Wind

- "funnel" the wind and measure changes in velocity
- how does height above the ground affect wind velocity?
- design a rotor to turn a bicycle electrical generator.

Wood

- burn samples of different species and record liberated heat (green, seasoned)

Biofuels

- produce biogas from waste (methane)
- produce ethanol from corn, wheat, etc.

Conservation

- incandescent vs. fluorescent light comparisons
- measuring thermal transfer through various materials
- heat retention of materials
- demonstrate the thermosiphon effect in air/water

General

- make and study a thermocouple
- electrolysis of water

PROJECTS

Solar

- sundial
- solar H20 heater
- window room heater (air)
- solar dryer (wood, food)
- solar match

Wind

- build a propeller
- build a Savonius wind turbine
- build a Darrious wind turbine

Wood

- build a wood stove
- produce methanol from wood (wood distillation)

Conservation

- food cooking in a hot box
- assist in making your home more energy efficient
- build a composter

General

- build a heat exchanger (air/water, water/water)

ACTIVITIES

Solar

- measure solar azimuth/altitude
- construct a "parabolic reflector" and use it to concentrate solar energy
- build a model greenhouse
- take photovoltaic readings

Wind

- make an anemometer
- make a pinwheel

Wood

- study wood stove designs/efficiencies
- research BTU value of various species

Biofuels

- field trip to sewage treatment plant which uses methane gas

Conservation

- which home appliances consume the most energy?
- compare various retrofit measures using "R" values and mathematics
- "energy conservation" poster contest
- adjust thermostat to 18° celsius by day, 16° celsius by night. Compare energy consumption. Calculate degree days for a week.
- read a watt/hour metre; record and calculate. Find the "R" value of a home's interior wall
- discuss and implement energy conserving measures in a home situation
- conduct a neighbourhood energy audit
- design an energy conservation crossword puzzle

APPENDIX A

AVIATION PIONEERS OF CANADA

Harold A. "Doc" Oaks. Organized operation of flying services in Northern Ontario, Manitoba and Saskatchewan and was Western Canada Airway's first manager.

Clennell H. "Punch" Dickens. Organized air services to the far North and awarded the distinguished flying cross for gallantry in the First World War.

Wilfred Reid "Wop" May. Involved in the inauguration of commercial airways air mail route over the remote territory of Western Canada and was awarded the distinguish flying cross for gallantry in the First World War. Later became director of Northern Development with Canadian Pacific Airlines in 1946.

John Henry "Tuddy" Tudhope. Involved in the inauguration of airmail services in Canada, and later became General Manager Operations of Trans Canada Airlines in Winnipeg in 1943.

George H. R. Phillips. Carried out many hazardous flights in the performance of his duty in forestry and fire controls, and took an active part in the training of pilots for the Ontario Provincial air service and later became a flying instructor at Camp Borden.

Maurice "Moss" Burbridge. Instructor of the Edmonton and Northern Alberta Aeroclub in Edmonton.

Walter E. Gilbert. Involved in exploratory flights in Northern Canada in the 20's and 30's and author of the book 'Arctic Pilot'.

Elmer G. Fullerton. Chief Instructor an instrument flying at Camp Borden. Appointed chief flying instructor in 1930.

William Munroe "Roe" Archibald. Organized the flying services of the Consolidated Mining and Smelting Company, Trail, B.C.

Arthur Massey "Matt Merry". Chief Pilot with Northern Aerial Minerals exploration in 1932, and also the MacKenzie Air Service, and was involved in hazardous flights to the Arctic coast and some outstanding mercy flights. Helped to forge the legend of the bush pilot.

J.P. Romeo Vachon. Involved in the development of air services on the north short of the Gulf of St. Lawrence.

Philip G. Johnson. Involved in the inauguration and outstanding progress of Trans Canada Airlines.

Murtin A. Seymour. Provided outstanding leadership to the flying clubs of Canada.

Thomas W. "Tommy" Siers. Appointed general superintendent of maintenance for Canadian Pacific Airlines in Montreal in 1943. Was involved in the development of the Worth principle of oil dilution for air craft engines, thereby facilitating easy starting of aircraft engines in cold weather.

A. Daniel "Dan" McLean. Controller of civil aviation of the Department of Transport, Ottawa.

Thomas Mayne "Pat" Reid. Aviation salesman with Imperial Oil Limited.

John Armistead "J.A." Wilson. Involved in the development of international aeronautics as well as civil aviation in Canada, and the development of the British Commonwealth air training plan. Was known for many years as the father of civil engineering in Canada.

George William "Grant" McConachie. Became assistant to the President of Canadian Pacific Airlines in 1946.

Zebulon Lewis Leigh. Officer and pilot of the RCAF and a 20 year record of achievement in civil and aviation, and was appointed commanding officer of the RCAF station at Goose Bay, Labrador in 1946.

Bernard A. "Barney" Rawson. Professional pilot, captained more than 100 types of aircrafts, and originated the national air show at the CNE Exhibition in 1953.

Roland B. West. Involved in search and rescue operations with RCAF.

Dennis K. Yorath. President of the Royal Canadian Flying clubs association in 1950.

Carl C. Agar. Involved with the use of rotary wing aircraft over mountainous terrain and became manager of Okanagan air services at Vancouver International Airport. Designed and built the first helicopter to be certified in the British Commonwealth (the Omega).

Philip C. Garrett. Vice president and managing director of deHaviland Aircraft of Canada Limited Designer and manufacture of Beaver aircraft was under Philip Garrett's direction, as well as, the prototype of the DHC-3 Otter. Vice President Managing Director of deHaviLand for 35 years, and under his management utility type transport aircraft were designed.

Keith R. Greenaway. Internationally recognized authority on aerial navigation with particular reference to polar flying and author of numerous publications on air navigation.

Franklin I. "Frank" Young. Director of the Royal Canadian Flying Club's Association in 1951, and piloted Trans Canada airlines first official flight from Toronto to New York in 1941. Later in 1945 appointed operations manager for the central region of Trans Canada airlines in Toronto.

Jerrauld G. "Jerry" Wright. Inventor of the R. Theta navigation computer system, which was used for navigational use by the RCAF in long range high speed aircraft. Also designed and invented the synchronized astro compass, the air navigation and tactical control (antac 12) system for Argus aircraft - the JGW Compass Systems, (standardized by the RCAF) and the CLS compass system, and the Mark 3 Position and Homing Indicator.

Gerald Lester "Jerry" MacInnis. Involved with the distant early warning line operations in the Canadian eastern arctic, and later became chief of flight operations for the Dept. of Transport.

Robert T. "Bob" Heaslip. Involved with helicopter operations during the construction of the mid Canada line (electronic warning network). Later became operations officer at Trenton, Ontario in 1966 and marketing manager with deHaviLand aircraft company.

John G. Jack Showler. Involved with the mapping of the arctic, and later became

Director of Transport and Reconnaissance Operations in Ottawa.

Juan Zurakowski. Involved with experimental flying of jet aircraft in Canada. Commander of the No. 316 Polish fighter squadron in England during World War II, and developed a new aerobatic manoeuvre known as the Zurabatic Cartwheel. Worked with Avro Aircraft Limited of Toronto, and test flew the CF100 with first jet inceptor aircraft, designed and built in Canada, as well as, the Avro Arrow first test flight in 1958.

John A.D. McCurdy. Assistant toAlexander Graham Bell involved with the creation of the Aerial Experimental Association. Later in World War II became assistant Director General of Aircraft Productions, Department of Munitions and Supply. With the association he worked on the Sygnet, and the production of many power flying machines including the Red Wing, the White Wing and the Silver Dart.

W.G. Leach. Involved in research in the first of high altitudes physiology. Medical officer with the RCAF, and later was promoted to Brigadier General, and Deputy Surgeon General of Operations on the staff of the Surgeon General.

Welland W. "Wheldy" Phipps. Involved with the development of landing gear which permitted the exploitation of short field characteristics of light aircraft operating from unprepared surfaces in the arctic. President and Chief Pilot and Chief Maintenance Engineer of Atlas Aviation in Resolute Bay.

Frank A. MacDougall. Forty year contribution to Canadian aviation.

Phillip C. Garrett. Retired Vice President and Managing Director to deHaviL and Aircraft Company of Canada.

Robert A."Bud" White. Set the absolute altitude record of 100,110 feet on December 14, 1967, and in 1969 became Director of Cadets at the Royal Military College, Kingston, Ontario.

M.W. “Max” Ward. President of Wardair and founder of Wardair Canada Limited.

Robert H. "Bob" Fowler. Chief Engineer and test pilot with deHaviLand Aircraft Company of Canada.

John A. M. "Jack"Austin. Retired President of Austin Airways Limited, Toronto.

David C.Fairbanks. Contributed to the development of Canada's STOL aircraft as a test pilot for 20 years.

E.Earl Godfrey. In 1942 was promoted to Air Vice Marshall. Involved with the first historic Trans Canada seaplane flight in 1926 and the first airmail flight from Ottawa to Vancouver in 1928.

Reference: Canada's Aviation Pioneers - 50 Years of McKee Trophy Winners by Alice Gibson Sutherland, Published by McGraw Hill Ryerson.

Canadian Transportation Statistics

- Most travel occurs using Canada's 850,000 km road network.
- About 90% of all domestic intercity travel by Canadians involves the use of an automobile.
- Everyday more than 145,000 Canadians travel between cities by bus, rail or car.
- Trains, trucks and ships move almost 2.3 million tonnes of freight each day.
- Twenty-five large deep water ports and 476 small harbours handle 327 million tonnes of commodities in 1992.
- There are 1,278 licensed airports, 10 of which handle 81% of all the traffic.

APPENDIX B

WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM

The following information is extracted from the Government of Canada Workplace Hazardous Materials Information System (WHMIS) to provide supplementary information for school safety programs. The pertinent sections of the Occupational *Health and Safety Act–Statues of Nova Scotia–Acts of 1985*, Chapter 3, contain specific information pertaining to the following topics: the right to know, joint health and safety committee requirements, duties of the employer and employee, toxic substances, and right of refusal.

Through legislation, the WHMIS has established uniform national requirements to ensure that information regarding the hazards of materials produced, sold in, imported to, or used within Canadian workplaces is provided by suppliers to employers and employees.

A controlled product is defined as any product, material, or substance specified by the regulations to be included in any of the classes listed in Schedule II of the *Hazardous Products Act.* Suppliers must convey hazard information to purchasers by means of the correct labelling on the controlled products or containers of controlled products, as well as prescribed information on material safety data sheets (MSDS). Appropriate workplace labelling and other forms of warnings about controlled products and the ready availability of MSDS's are also part of the system.

Suppliers are also responsible for evaluating their products using the hazard criteria identified in the controlled products regulations of the *Hazardous Products Act.* The hazard classes specified in the Act are:

- compressed gas
- flammable and combustible materials
- oxidizing materials
- poisonous and infectious material
- corrosive material
- dangerously reactive material

Suppliers must be sure that containers of controlled products leaving their premises are labelled with a product identifer (e.g., brand name, code name, or chemical name of the product), appropriate hazard symbols, risk phrases, precautionary measures, first aid measures, and the name and address of the manufacture or other supplier. Labels must be legible and in both official languages, prominently displayed, and must make reference to the material safety data sheet. As long as the controlled product remains in the supplier–provided container, it must be ensured that the WHMIS supplier label remains on it or is attached to the container and is legible.

Suppliers must prepare or obtain MSDSs in both official languages for each controlled product they sell or import, and are required to provide MSDSs in the official language or languages requested by the purchaser. There are minimum content requirements for MSDSs. Beyond the product identity information, the supplier must give properties, prevention and first aid measures, and the name and telephone numbers of persons or corporate departments responsible for preparing the MSDSs to be contacted for additional information. MSDSs are to be updated at least every three years, or as soon as further information related to the hazard becomes available for a material. Copies of supplier and employer MSDSs for controlled products found in a given workplace are to be readily available in that workplace.

Supplier Identifier Labels
Containers of controlled products must have the appropriate supplier identifier labels. Minimum specifications for supplier labels are as follows:

- a product identifier
- brand name, code name, or chemical name
- a hazard symbol in a pictogram form
- risk phrases (e.g., toxic material–lung and eye irritant)
- precautionary measures (e.g., in case of eye contact, flush immediately)
- supplier identifiers (e.g., reference to MSDS for the product

NOTE:
Supplier and workplace labels (or signs, placards, tags, and other identifiers) are alerting mechanisms for workers using controlled materials which may be present in the workplace in pipes, tanks, and portable containers. Also, where a controlled product is in a container other than the container in which it was received from the supplier, the container must have a workplace label.

Material Safety Data Sheet
These are different but complementary to the supplier identification labels mentioned above, and include all the available significant information in the appropriate manner using prescribed headings. They must be complete including all the information on all the hazards, such as:

- safe work procedures
- choice of proper safe protection equipment
- procedures to be followed in emergencies
- data for monitoring workplace conditions and health of exposed workers

The prescribed headings for Materials Safety Data Sheets are as follows:

- product identifier–commercial name of the product
- hazardous ingredients and the approximate percentage composition of these ingredients
- physical data such as specific gravity, volatility, vapour pressure at specified temperatures, etc.,
- fire and explosion hazard (i.e., flashpoint)
- reactivity data–dangerous reaction with other chemicals which may occur under conditions of normal use
- toxilogical properties of the controlled product are to be listed (i.e., acute or chronic human health effects related to the types of exposure possibly related to workplace conditions)
- first aid measures

- preparation information–name of contact group for obtaining additional information and the date of the preparation of the MSDS. MSDSs must be stored or positioned where they are easily consulted by people working in the workplace

NOTE:
It is imperative that all public school programs, especially those in industrial arts technology, follow the appropriate storage and disposal procedures outlined in the Material Safety Data Sheet for all hazardous materials used in that program. Further information can be obtained by contacting these sources of information and assistance.

Health and Safety Information via Internet
Health and safety information is now available via the Internet. The Canadian Centre for Occupational Health and Safety (CCOHS) has a comprehensive collection of occupational health and safety databases including material safety data sheets (MSDS), chemical profiles, noise level measurements, legislative information, and reference to research papers on many occupational health and safety topics, now available via Internet. For additional information, contact CCOHS customer service at (800) 668-4284, or (905) 570-8094, or Fax (905) 572-2206, or by Internet e–mail at custserv@ccohs.ca.

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