Power and Energy 3201

Government of Newfoundland and Labrador
Department of Education

Curriculum Guide (Interim)

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Program Overview and Rationale

Background

Power and Energy 3211 is based conceptually, philosophically and practically on the Atlantic Canada Foundation document for Technology Education (2001). The teacher is directed to the document for specific information that forms the basis for this and other technology education curricula in the province of Newfoundland and Labrador.

This two-term course replaces the one-term technology education course, Power Mechanics 2103. While content from this course that addresses the General Curriculum Outcomes (GCOs) is retained, Power and Energy 3201 features additional topics dealing with alternative energy production and a delivery model that reflects the learning philosophy of the modular approach and experiential learning.

Rationale

In the power generation sector, alternative energy is the newest answer to environmental concerns. Working with renewable and inexhaustible sources, alternative energy solutions are present in many energy plans around the world, and specifically mentioned in the Energy Plan for Newfoundland and Labrador. Electricians in the near future will need to be familiar with a variety of alternative energy solutions, how best to implement them and how to install them. In this manner, the energy section of this course encompasses the future of skilled trades in electricity. Students will be exposed to actual working models of wind turbines, solar cells, power distribution systems, fuel cells and a variety of electrical technologies that are on the cutting edge of the alternative energy sector. They will also be introduced to topics dealing with apprenticeship and Occupational Health and Safety to ensure they are exposed to post-secondary options and the world of work.

The second part of the Power and Energy course will involve examining power usage through experiential work with engines. Within the automotive and mechanical sectors a variety of engine types and methods are used. Within this course these will be explored through the study of small engines, troubleshooting and tear downs. Working in groups; students will work with the small engine, becoming familiar with it and the series of systems from which it is made up. Students will learn about working with these engines experientially and develop skills that are specific to the small engine sector. They will explore the engine-base skilled trades and have a sense of what a career in this area will entail.

Rationale cont.

The Futures in Skilled Trades and Technology Program is not intended to offer trades-based training in the high school environment, but rather give students an opportunity to explore careers in the skilled trades and learn new skills through real-world experiential learning.

In this manner the Power and Energy 3201 course will give students a chance to meaningfully experience the automotive/small engine and electrical trades and completes the full suite of courses in the program. Students completing this course and the complementary Career Development 2201 course should be well prepared for making good career choices after high school.

Purpose of Curriculum Guide

The purpose of this curriculum guide is to provide the teacher with a clear picture of expectations for learning in the course. The guide includes the specific curriculum outcomes, suggested learning and teaching strategies, suggested assessment and evaluation strategies and support resources.

Context for Teaching and Learning

As stated in the Atlantic Canada Foundation document for Technology Education (2001), the technology education curriculum in Atlantic Canada adheres to principles that guide decisions shaping the continuous improvement of learning and teaching including the design and implementation of the curriculum. These include:

Authenticity

Technology education values and embraces the strategic links between applied learning and integrated learning.

Unity

Technology education values and embraces meaningful connections among diverse areas of study.

Constructivism

Technology education incorporates each individual's prior knowledge, skills, and attitudes in the design of authentic learning experiences.

Context for Learning cont.

Collaboration

Technology education curriculum in Atlantic Canada adheres to strategies that emphasize the unifying concepts of related disciplines, particularly science.

Autonomy

Technology education values an environment with the learner as its pivotal force.

Continuous Inquiry

Continuous inquiry is essential to technology education.

Continuous Improvement

The success of technology education initiatives is a function of informed implementation and improvement practices.

Continuous Learning

Technology education implies strategic and distinct pre-service and in-service demands on teacher education.

Power and Energy 3201 encourages student collaboration in solving technical problems and reflects true industry practice through the use of a problem-based learning approach. Continuous inquiry, improvement and learning are fundamental to this approach and the design project provides an authentic learning experience where students direct the learning.

Literacy through Technology Education

As noted in the Atlantic Canada Foundation document on Technology Education, in order to acquire technological "literacy", students must be given the opportunity to actively participate in the solution of technical problems. In support of this, it is recommended that delivery of Power and Energy 3201 be focused on the shop/lab setting with intermittent classroom instruction as required. Accordingly, the course is designed for 80% lab and 20% class delivery. This emphasis on practical experiential learning opportunities for students is consistent with instructional delivery models used in post-secondary skilled trades programs.
Trades apprentices seeking journeyperson certification, for example, are required to complete a training program that consists of 20% classroom-based instruction and 80% field experience. This mode of instructional delivery provides students with opportunities to:

- Identify, assess, and make decisions about their use of technological resources
- Assess their technological literacy/capability in the context of specific situations
- Develop personal action plans to acquire specific technical skills and capabilities

Literacy through Technology Education cont.

- Safely use a wide variety of technological systems, tools, and other resources
- Identify and address technological issues and situations important to them
- Design, develop, and articulate technological solutions to a wide range of problems
- Articulate ideas and take intellectual risks
- Reflect on and evaluate learning
- Reflect on, evaluate, and express ideas and opinions on the relationship between technology and education and the role of technology education
- Assess technology as a force for change in a variety of workplaces, jobs, occupations, and careers

The modular approach is particularly important to providing students with each of these learning opportunities. It allows students to individually experience all of the learning opportunities while the teacher's role becomes that of facilitator. In a modular, setting learning stations are set within the fabrication lab which will meet the learning objectives while producing a variety of learning experiences occurring at the same time.

Meeting the Needs of All Learners

In the Atlantic Canada Foundation document on Technology Education (2001), it is suggested that in a learning community characterized by mutual trust, acceptance, and respect, student diversity is both recognized and valued. Educators should ensure that classroom practices and resources positively and accurately reflect diverse perspectives and reject prejudicial attitudes and discriminatory behaviours. It is also suggested in the document that if curriculum is to contribute to the achievement of equity and quality in education, it must:

- Reflect students' abilities, needs, interests, and learning styles
- Expect that all students will be successful regardless of gender, racial and ethno-cultural background, socioeconomic status, lifestyle, or ability
- Enable students to value individual variation among members of their classroom community

Power and Energy 3201 considers a wide range of learners and learning styles through a problem-based learning approach that encourages experiential learning. This student-centered learning model emphasizes a group approach to problem-solving that requires students to take ownership of their own learning. As suggested in the Atlantic Canada Foundation document on Technology Education (2001), taking ownership and responsibility for their own learning is a significant element in the growth of a student's technological capability.

Effective Assessment and Evaluation Practices

The Atlantic Canada Foundation document on Technology Education (2001), recommends that in planning assessments, teachers should use a broad range of strategies in an appropriate balance to give students multiple opportunities to demonstrate their knowledge, skills, and attitudes. The document identifies many types of assessment strategies as suitable for technology education including:

- Formal and informal observations
- Work samples
- Anecdotal records
- Conferences
- Teacher-made and other tests
- Portfolios
- Learning journals
- Questioning
- Performance assessment
- Peer and self-assessment
- Available information
- Using a high level of professional judgment in making decisions based upon information

Similarly, the document suggests that evaluation involves teachers and others in analyzing and reflecting upon information about student learning gathered in a variety of ways. The process requires:

- Developing clear criteria and guidelines for assigning marks or grades to student work
- Synthesizing information from multiple sources
- Weighing and balancing all available information
- Using a high level of professional judgment in making decisions based upon information

Assessment and evaluation in Power and Energy 3201 must consider both the problem-based learning approach used and the required General Curriculum Outcomes (GCOs) outlined in the Atlantic Canada Foundation document on Technology Education. The assessment strategies recommended in section III of this guide, reflect these requirements.

Program Design and Components

Program Components

Power and Energy 3211 is one of two Level III technology education courses that introduce students to a wide variety of technologies and problem-solving strategies that reflect industry practice. This course does not have a pre-requisite although knowledge and skills gained in the Energy and Power Technology Module in the intermediate grades will be of use to the student. This course is the final one in the skilled trades are for the *Futures in Skilled Trades and Technology Program.*

Outcomes Structures

The course curriculum is structured to address outcomes as suggested in the Atlantic Canada Foundation Document for Technology Education (2001). These include Essential Graduation Learnings (EGLs), General Curriculum Outcomes (GCOs), Key Stage Curriculum Outcomes (KSCOs) and Specific Curriculum Outcomes (SCOs).

EGLs are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school.

GCOs are statements that identify what students are expected to know and be able to do upon completion of study in a curriculum area.

KSCOs provide additional detail for each of the GCOs and provide a means to quickly assess progress in a subject area at the end of a level of schooling. SCOs identify what students are expected to know and be able to do at a particular grade level.

The EGLs specified in the Atlantic Canada Foundation document on Technology Education include:

Essential Graduation Learnings

Asthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through art.

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Communication

Graduates will be able to use listening, viewing, speaking, reading, and writing modes of language(s) and mathematical and scientific concepts and symbols, to think, learn, and communicate effectively.

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving

Graduates will be able to use strategies and processes needed to solve a wide variety of problems, including those requiring language and mathematical and scientific concepts.

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

Spiritual and Moral Development

Graduates will be able to demonstrate understanding and appreciation for the place of belief systems in shaping the development of moral values and ethical content.

General Curriculum Outcomes

The GCOs for technology education as defined in the Atlantic Canada Foundation document on Technology Education include:

GCO 1: Technological Problem Solving

Students will be expected to design, develop, evaluate, and articulate technological solutions.

GCO 2: Technological Systems

Students will be expected to evaluate and manage technological systems

GCO 3: History and Evolution of Technology

Students will be expected to demonstrate an understanding of the history and evolution of technology, and of its social and cultural implications.

GCO 4: Technology and Careers

Students will be expected to demonstrate an understanding of current and evolving careers and of the influence of technology on the nature of work.

GCO 5: Technological Responsibility

Students will be expected to demonstrate an understanding of the consequences of their technological choices.

Key Stage Curriculum Outcomes

The KSCOs for Power and Energy 3201 are based on the five previously noted GCO's and indicate what is expected of students at the end of Level III. By the end of Level III, students will be expected to:

GCO 1: Technological Problem Solving

[1.401] articulate problems that may be solved through technological means

- assess diverse needs and opportunities
- construct detailed design briefs that include design criteria and a work schedule

[1.402] conduct design studies to identify a technological solution to a problem

- investigate related solutions
- document a range of options to solve this problem
- determine and justify the best option
- determine resource requirements and availability
- develop detailed action plans, including technical drawings and sequences of action

Key Stage Curriculum Outcomes (cont'd)

GCO 1: Technological Problem Solving

[1.403] develop (prototype, fabricate, make) technological solutions to problems

- match resources and technical processes for specific tasks
- construct and test models and prototypes as needed
- construct the solution with adherence to the design criteria
- document activities, decisions, and milestones

[1.404] critically evaluate technological solutions and report their findings

- develop detailed evaluations of both their own and others' technological solutions, with reference to independently developed criteria
- employ a continuous assessment methodology with the purpose of continuous improvement of the design
- document and report their changes, the rationale for change, and conclusions

[1.405] communicate ideas and information about technological solutions through appropriate technical means

- accurately present technical information by using a representative sample of analog and digital tools, including, for example, two- and three-dimensional computer-assisted drafting and modeling tools
- create accurately scaled models and prototypes

GCO 2: Technological Systems

[2.401] operate, monitor, and adjust technological systems of increasing complexity

[2.402] manage technological systems of increasing complexity

[2.403] modify programming logic and control systems to optimize the behaviour of systems

[2.404] deconstruct complex technological systems into their simpler systems and components

[2.405] troubleshoot and maintain systems

GCO 3: History and Evolution of Technology

[3.401] evaluate technological systems in the context of convergence where one system has multiple functions, or divergence where multiple systems have the same function

[3.402] evaluate the symbiotic roles of technology and science in modern society

[3.403] analyse the symbiotic relationship between technology and education, including factors that influence standards for technological literacy and capability, and ways that the community responds

[3.404] critically evaluate the effects of accelerating rates of technological change on self and society

[3.405] account for effects of cultural diversity on technological solutions

- critically examine the effects of cultural diversity on market forces and technological products, and vice versa
- incorporate knowledge of cultural diversity into development of technological solutions

GCO 4: Technology and Careers

[4.401] assess and evaluate employability profiles for a variety of workplaces and careers and determine the level of technological literacy and capability they would need to achieve for job entry

[4.402] employ design and invention as tools to create entrepreneurial activity

[4.403] envision their short and longer-term future and develop a plan for acquiring the technological literacy/capability required to achieve their vision

GCO 5: Technological Responsibility

[5.401] demonstrate responsible leadership in employing legal and ethical rules and principles

[5.402] demonstrate responsible leadership in employing health and safety rules and standards

[5.403] demonstrate responsible leadership in taking proper measures to manage current and future technological risk

Specific Curriculum Outcomes

Overview

The Specific Curriculum Outcomes (SCOs) for the Power and Energy 3201 Curriculum Guide are derived from Stage 4 (Grade 10-12) of the Key Stage Curriculum Outcomes (KSCOs) outlined in the Atlantic Canada Foundation document for Technology Education (2001). The SCOs are organized into six units:

- Unit 1: Safety
- Unit 2: Power Overview
- Unit 3: Experiencing Small Engines Modularly
- Unit 4: Introduction to Alternative Energy
- Unit 5: Experiencing Alternative Energy Modularly

It is recommended that unit 1 be covered before any other units. Unit 2 and 3 are intended to be taught together and unit 4 and 5 are intended to be taught together. This can be done in a number of ways either by using modules or by "flipping" the class after half the course is completed.

Unit 2 and 3 contain the research and hands-on work involved in small engine tear down and troubleshooting. Working in groups of two, on modular-based projects, students are required to tear down and reassemble a small engine. They are the expected to use the knowledge gained in a series of troubleshooting tasks. Evaluation of the outcome is based on the ability to identify all the working pieces, reassemble the engine and successfully troubleshoot a minor problem.

Unit 4 and 5 are the theory and practice of working with alternative energy units. From wind energy to solar to fuel cell technology, students will learn the processes involved and some of the theory behind these innovative energy solutions.

Each unit consists of several topics that address the General Curriculum Outcomes (GCOs) detailed in the Atlantic Canada Foundation document for Technology Education (2001). Units are sequenced to introduce theory before hands-on practice.

Overview cont.

The five units that comprise Power and Energy include the following key topics for a total of 110 hours instructional time:

Unit 1: Safety (10 hours)

- Topic 1: General Fabrication Room Safety (6 hours)
- Topic 2: Occupational Health and Safety (4 hours)

Unit 2: Introduction to Engines (4 hours)

- Topic 1: Introduction to Engines (4 hours)

Unit 3: Experiencing Small Engines Modularly (46 hours)

- Topic 1: Small Engine Overview (4 hours)
- Topic 2: Ignition Systems (7 hours)
- Topic 3: Fuel System (7 hours)
- Topic 4: Valve Train/Timing System (7 hours)
- Topic 5: Compression System (7 hours)
- Topic 6: Lubrication/Cooling System (7 hours)
- Topic 7: Mechanical System (7 hours)

Unit 4: Alternative Energy (10 hours)

- Topic 1: Types of Energy (3 hours)
- Topic 2: Sources of Energy (3 hours)
- Topic 3: Power and Energy Overview (4 hours)

Unit 5: Experiencing Alternative Energy Modularly (40 hours)

- Topic 1: Hydrogen Fuel Cell Technology (8 hours)
- Topic 2: Wind Turbines Technology (8 hours)
- Topic 3: Solar Cell Technology (8 Hours)
- Topic 4: Heat Pump Technology (8 hours)
- Topic 5: Service Panel Wiring for Off-the-grid Technologies (8 hours)

Note that the times allocated to each topic are recommendations only.

The 4-column Layout

The 4-column layout in the curriculum guide spans across two pages and presents the necessary information to the teacher to deliver a particular course topic to the student. The 4-column layout consists of:

I Specific Curriculum Outcomes.

The first column will contain one or more SCOs from the course that will be addressed by the organizer. Each SCO also contains a listing of the KSCOs to which it directly relates (the relative KSCOs are included in brackets). The KSCO would be those for the subject area the course fits.

II Suggested Teaching and Learning Strategies.

Suggested Teaching and Learning Strategies are recommendations for implementing the curriculum. This section could include Teacher Preparation and Sample Student Activities sections.

III Suggested Assessment Strategies.

Suggested Assessment and Evaluation Strategies are recommendations for determining student achievement. Suggestions are provided to assist the teacher with the evaluation and assessment of student activity.

IV Resources.

This column provides additional information that may be of help to the teacher in lesson planning. References to teacher and student texts and other resources are included here. The teacher is encouraged to expand and elaborate upon the information presented in columns II, III and IV.

Unit 1: Safety

Unit 1 Overview

The purpose of this unit is to provide students with an introduction to the operation and environment of an industrial shop. Students will learn how to operate tools and machinery specific to the power and energy world. They will learn to use them properly and safely within the fabrication lab environment and the real world. This unit also introduces the concepts of WHMIS and OH&S to students. An important topic for the young worker, the OH&S section will serve as a learning object with regards to worker's safety and worker's rights.

The purpose of this unit is for students to acquire a good respect for rules and safety regulations within the fabrication room. In the same respect, it is important for students to realize that the same safe practice, care and concern they exhibit in this environment should also be transferred to any work site they are involved in.

Organization

The following unit topics will provide these experiences:

- **Topic 1:** General Fabrication Room Safety (6 hours)
- **Topic 2:** Occupational Health and Safety (4 hours)

These two topic areas encompass important parts of the curriculum dealing with young workers and workers' safety. Students who are not well versed in safety regulations within the fabrication room area should not be permitted in the fabrication room area.

Assessment

This is an assessment for learning section, students should continue with the assessments in each case until they are able to complete it with 100% accuracy. This section constitutes approximately 10% of the course time and the value attributed to it should reflect that status.

Topic 1 General Fabrication Room Safety

Specific Curriculum Outcomes

Students will be expected to

1.1.1 identify common hazards within the Fabrication Room environment. [5.102, 5.302]

Suggested Learning and Teaching Strategies

Safety rules within the fabrication lab should be clearly and prominently displayed. One of the first activities for students in this course should be to design and implement a safety information program within the lab site. This will enable students to become aware of the common hazards in the fabrication lab, while taking personal responsibility for identification and awareness for others using the space. This also ties in with the following outcome and can be taught in conjunction with it.

This outcome ties in directly with the unit 2 topic on OH&S and specifically the SAFE work program. The first step in that program is: Spot the hazard.

All students should walk through their fabrication space and identify the hazards.

Student Activity:

There are a variety of activities around this topic. A quick tour of the fabrication room pointing out hazards to students is one directed way to introduce this, but in most cases having students in small groups do a quick tour and then move into a whole class discussion revolving around the topic may be the most effective. Students could then compare notes in their discussion, defending what they did or did not see as being a hazard. This will allow for a clearer definition and inevitably a safer fabrication room overall.

Topic 1 General Fabrication Room Safety

Suggestions for Assessment

Practical Activity

- Students create rules, messaging, clear zones and floor plans to address potential hazards. This can form the basis of a design project with the inclusion of OH&S and safe work principles.

Group Activity

- Students audit the fabrication lab themselves for hazards. Each group could do an assessment of the space and then compare notes with the other groups.

Work Log

- Students keep a record of the common hazards in the fabrication lab within their work log. As this is the first activity for the work log an introduction of purpose, role in the assessment process and what should or should not be entered into it should take place at this point.

Resources

WEB

- Workplace Health, Safety and Compensation Commission - http://www.whscc.nl.ca/
- Safe Work Newfoundland and Labrador - http://209.128.14.165/

Topic 1 General Fabrication Room Safety

Specific Curriculum Outcomes

Students will be expected to

1.1.2 demonstrate safe practice for use of hand tools and power tools specific to mechanical repair and maintenance. [5.102]

Suggested Learning and Teaching Strategies

Working with a wide variety of tools is integral to most of the skilled trades. For power tools in particular, ensuring students are properly certified to use them is essential. Normal practice is to use a combination of written and performance testing for each student for each tool. It is a good idea to maintain a chart of who is qualified for what tools. You may wish to provide class wide instruction on tools, followed by individual testing. It is to be expected that not all students will qualify for all tools and that students who qualify for different tools will specialize in those during the accomplishment of tasks.

Points to emphasize

- Safety is not just a set of rules. Safety is a way of life. It is a set of ideas, attitudes, behaviours and practices that are essential to the workplace. Safe practice does not eliminate risk, but it reduces risk. Safe practice is risk management.
- Safe use of tools is primarily using them in the prescribed manner, with the proper adjustments and usage procedures. It is also avoidance of clearly understood unsafe practices. In particular, shortcuts and non-standard use often increase risk.
- Only students who are qualified will be allowed to use a particular tool. It is not necessary for all students to use all tools. It is perfectly acceptable within a group to divide the tasks so that each member can qualify for a different group of tools.
- Tool qualification can occur on an as-needed basis.
- Tool qualification has no margin of error. Only 100% on written / verbal / performance tests are acceptable for qualification.
- Each tool is different but all tools have commonalities. Point out the commonalities with other tools when demonstrating a tool's function, adjustments and operating procedures.

Topic 1 General Fabrication Room Safety

Suggestions for Assessment

Pencil and Paper

- Students are expected to complete a written safety test (passing grade is 100%) and complete a practical safety demonstration for each of the hand, portable power, and stationary power tools to be used in the fabrication laboratory. These tests are available in the Skilled Trades Safety Guide.

Work Log

- Students report in their work log book each tool they are qualified to use, and the date and time of the qualification.

Discussion

- Students engage in a discussion about why tool safety is so important and why there is a need for safety tests and demonstrations. An extenstion could include discussing what sort of safe work inspections may or may not be in place on the work site.

Resources

TEXT

- Skilled Trades Safety Guide -
  - Appendix A - Safe Operating Procedures and Safety Tests
  - Appendix B - Tool Safety Sheets

WEB

- Pennsylvania Safety Guide - http://workforce.cup.edu/komacek/pasafetyguide.pdf
- Heads Up for Safety (BC) - http://www.bced.gov.bc.ca/irp/resdocs/headsup.pdf

Topic 1 General Fabrication Room Safety

Specific Curriculum Outcomes

Students will be expected to

1.1.2 demonstrate safe practice for use of hand tools and power tools specific to mechanical repair and maintenance. [5.102]

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Suggested Learning and Teaching Strategies

It may be useful to take some class time and do an overview/ demonstration of all tools. Include:

- function of the tool;
- parts of the tool;
- adjustments that can be made and the correct procedure for completing them;
- safe usage of the tool for performing the common tasks; and
- procedures to follow in instances where the tool is not functioning or functioning outside the specifications.

Student Activity:

Students should

- complete the safety program for each tool that requires it, and is intended for use;
- state and describe the safe operating procedure for using a tool at 100% accuracy;
- demonstrate safe use of a tool with 100% accuracy;
- record certification for tool in the work log and have the teacher initial it; and
- use tools as needed, in accordance with accepted safe practices.

Topic 1 General Fabrication Room Safety

Suggestions for Assessment

Resources

Topic 1 General Fabrication Room Safety

Specific Curriculum Outcomes

Students will be expected to

1.1.3 demonstrate safe practices within the fabrication area, and proper procedure for handling shop emergencies. [5.102, 5.103]

1.1.4 understand the importance of WHMIS and demonstrate knowledge of its key features. [5.102, 5.103]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to formalize the safety procedures established in classrooms and laboratories. Teachers should outline the various contingencies and the proper safe response by students. These should include but are not limited to:

- fire extinguishers;
- eye wash station;
- fire exits;
- emergency shut-off; and
- first aid kit.

Student Activity:

- Students could participate in a mock emergency within the fabrication lab. This simulation should involve injury, fire, electrical situations and chemical spills.

WHMIS is an acronym for Workplace Hazardous Materials Information System. It involves a series of national regulations concerning the communication of information about the use and storage of hazardous material in the workplace. Science 1206 and the locally developed Workplace Safety 3220 both present a short course in WHMIS. In this course we will cover the basics of the system and applicable sections for the fabrication lab.

The details that must be covered include:

- supplier label;
- workplace label;
- material safety data sheets (MSDS); and
- employee education.

Topic 1 General Fabrication Room Safety

Suggestions for Assessment

Practical Activity

- Students draw a floor plan of the fabrication room indicating on it all of the emergency materials and their location. As part of a class discussion justification for placements of tools and equipment could be given and defended.

Research/Paper and Pencil

- Students choose a common hazardous material in the fabrication lab and research the relevant Material Safety Data Sheet. A report to the instructor should be prepared on this material, its use and storage in the Fabrication Lab.

Work Log Book

- Students could record in their work logs the completion of this section on WHMIS.

Resources

MATERIALS

- Fabrication Room Floorplan

TEXT

- Science 1206 Curriculum Guide

WEB

- Government of Canada WHMIS Site - http://www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/index-eng.php

Topic 1 General Fabrication Room Safety

Specific Curriculum Outcomes

Students will be expected to

1.1.5 recognize the need to consult Material Safety Data Sheets (MSDS) when handling chemicals. [5.102]

Suggested Learning and Teaching Strategies

The material safety data sheets are provided with all hazardous materials defined as those having the potential to cause a physical or health hazard.

The different classes of such material are:

- Class A - compressed gas;
- Class B - flammable and combustible material;
- Class C - oxidizing material;
- Class D - poisonous and infectious material;
- Class E - corrosive material; and
- Class F - dangerously reactive material.

Student Activity:

Students could choose a common hazardous material in the fabrication lab and research the relevant material safety data sheet. A report to the instructor should be prepared on this material, its use and storage in the fabrication lab.

Topic 1 General Fabrication Room Safety

Suggestions for Assessment

Assignment/Presentation

Students review the details of WHMIS, specifically:

- supplier label;
- workplace label;
- material safety data sheets (MSDS); and
- employee education.

and create a brochure to explain the program. This brochure should be written in such a way that a student who has never seen the WHMIS system would be able to understand it.

Resources

MATERIALS

- Fabrication Room Floorplan

Topic 2 Occupational Health and Safety

Specific Curriculum Outcomes

Students will be expected to

1.2.1 demonstrate knowledge of the Occupational Health and Safety Act. [5.402]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to make students aware of their rights and responsibilities as employees. The first step is awareness, with all stakeholders having the same level of responsibility to know the regulations. A suggested method of instructing this section is to use case studies. A role play would also be an appropriate strategy in this case. This outcome is best covered in tandem with the following outcome.

Introduce the SAFE work program sponsored by the Workplace Health, Safety & Compensation Commission (WHSCC)

Student Activity:
Set up a situation where an unsafe work practice is being undertaken. Students could work through the Occupational Health and Safety (OH&S) process considering the situation.

Students discuss the roles of the various stakeholders as you work through the process. Pay specific attention to:

- the worker;
- the OH&S committee;
- the employer; and
- commission officers.

Address some of the following terms in the role play:

- stop work
- risk.

Topic 2 Occupational Health and Safety

Suggestions for Assessment

Discussion

- Students discuss the origins of Occupational Health and Safety, how these regulations came into being and why they are strictly inforced.

Role Play/Simulation

- Students form their own OH&S committee within the class. Teachers take on the role of the employer, while students take on various roles within the business. Site visits, stop work orders, safe work inspections, and risk assessments could form the basis of this role play.

Log Book

- Students record their learning with regards to the SAFE work program. They could break down the learning into individual goals

Passport to Safety

- Students engage in the Passport to Safety safe work program online.

Resources

WEB

- Occupational Health and Safety Act - http://www.assembly.nl.ca/Legislation/sr/statutes/o03.htm
- Passport To Safety - http://www.passporttosafety.ca/
- Workplace Health, Safety and Compensation Act - http://www.assembly.nl.ca/legislation/sr/statutes/w11.htm
- Occupational Health and Safety Homepage - http://www.gs.gov.nl.ca/ohs/
- Safework Newfoundland and Labrador - http://209.128.14.165/

NOTES

- Appendix A - Notes Section pg. 1

Topic 2 Occupational Health and Safety

Specific Curriculum Outcomes

Students will be expected to

1.2.2 identify the rights and responsibilities of the various stakeholders including the right to refuse. [5.402]

Suggested Learning and Teaching Strategies

This outcome deals with the heart of the Occupational Health and Safety Act.
Workers in Canada have the following rights:

- The right to know.
- The right to participate and assist.
- The right to refuse.

Students should understand that as workers they have a right to know what potential hazards are present at a jobsite and the ways to prevent injury so that they may enjoy a safe working environment. They also have the right to participate and assist in the identification and resolution of workplace safety issues.

It is important to note that younger and/or new workers experience higher rates of injuries than do other workers and that knowledge of OH&S could help reduce those numbers considerably.

Student Activity:
Outcome 1.2.1 suggests a role play and mock situation that introduces students to the OH&S topic in general.
An extension of this could include the specific rights and responsibilities of employers and workers. This extension and the role play itself will ensure students have an appropriate understanding of this topic.

Topic 2 Occupational Health and Safety

Suggestions for Assessment

Practical Activity

- Students should be advocates for their own safety within the skilled trades and technology program. They should be aware of their work site and ensure that it remains safe for themselves and their classmates. Through formal discussion and presentations to the class, the instructor and other classes, students demonstrate this awareness and the importance of safe action.

Assignment

- Students create a brochure. The theme of the brochure could be, "Everything a young worker should know about Occupational Health and Safety." These materials and the content are found on the internet or a variety of sources available from OH&S.

Role Play

- All students should rotate through the role of the worker in the Occupational Health and Safety role play. Once in that position students represent themselves as workers, highlighting their rights and responsibilities in the role.

Pencil and Paper

- Students outline in their own words what they see as their rights and responsibilities as workers. A comparison could then be undertaken with the *Occupational Health and Safety Act* and materials to reinforce the understanding of this topic. Students encompass this material within their personal code of conduct contract in section 2.3.1.

Resources

WEB

- Occupational Health and Safety Act - http://www.assembly.nl.ca/Legislation/sr/statutes/o03.htm
- Passport To Safety - http://www.passporttosafety.ca/
- Workplace Health, Safety and Compensation Act - http://www.assembly.nl.ca/legislation/sr/statutes/w11.htm
- Occupational Health and Safety Homepage - http://www.gs.gov.nl.ca/ohs/
- Safework Newfoundland and Labrador - http://209.128.14.165/

NOTES

- Appendix A - Notes Section pg. 1

Topic 2 Occupational Health and Safety

Specific Curriculum Outcomes

Students will be expected to

1.2.3 explain the process for the reporting of risks, workplace issues and accidents. [5.402]

Suggested Learning and Teaching Strategies

Students explore the Occupational Health and Safety committee and the worker health and safety representative.

There are a variety of ways to introduce this topic, but consideration of combining this outcome with the previous is integral to the learning to take place. Students need to experience this material first hand, such that it becomes second nature to them.

Within the classroom a similar system for reporting such incidents could be put into place. Theory into practice, as students becomes arbiters of their own health and safety. This will take the role play a step beyond and make the fabrication lab safety a part of their learning.

A guest speaker at this point would also be of use. Occupational Health and Safety Officers are available for classroom presentations as well as the Youth Coordinator of the Workplace Health, Safety and Compensation Commission.

Student Activity:

Students form their own mock OH&S committee. All of the considerations for its formation should be brought into consideration and addressed in writing for the instructor.

This activity could be undertaken with the previous two outcomes, and become an integral part of the resolution of the incident.

Topic 2 Occupational Health and Safety

Suggestions for Assessment

Role Play

- The Occupational Health and Safety Committee, that could have been set up earlier in this section, could now be expanded to establish methods and processes for reporting issues, risks and accidents.

Work Log

- Students report on the processes of an Occupational Health and Safety committee in their log, specifying what they have learned.

Practical Activity/Discussion

- Students work to establish a reporting mechanism for their own fabrication lab. This will outline the steps to take in the event of a hazard being determined, an injury taking place or of potential issues. A discussion with the instructor and the class as a whole should be included.

Resources

WEB

- Occupational Health and Safety Act - http://www.assembly.nl.ca/Legislation/sr/statutes/o03.htm
- Passport To Safety - http://www.passporttosafety.ca/
- Workplace Health, Safety and Compensation Act - http://www.assembly.nl.ca/legislation/sr/statutes/w11.htm
- Occupational Health and Safety Homepage - http://www.gs.gov.nl.ca/ohs/
- Safework Newfoundland and Labrador - http://209.128.14.165/
- Role Play Templates
  - http://lamscommunity.org/lamscentral/sequence?seq_id=924470
  - http://www.learningdesigns.uow.edu.au/guides/info/g1/index.htm

NOTES

- Appendix A - Notes Section pg. 2

Topic 2 Occupational Health and Safety

Specific Curriculum Outcomes

Students will be expected to

1.2.4 explain the duties of OH&S Commission Officers. [5.402]

Suggested Learning and Teaching Strategies

OH&S inspections division consists of officers, industrial hygienists, engineers and radiation specialists. For the purposes of this outcome, we will focus on the group as a whole with specical consideration for commission officers.

The inspections division is responsible for:

- investigating workplace accidents and incidents;
- conducting compliance inspections and detailed audits of workplaces;
- hygiene assessments of various physical, chemical, biological and ergonomic agents in the workplace in order to protect worker health;
- evaluating and inspecting radiation control measures in workplaces; and
- enforcing Occupational Health and Safety Legislation.

The main tools of the commission officer are investigations, compliance inspections and workplace audits. All of these deal with accidents and incidents before, during and after their occurrence.

Student Activity:
Students can expand the discussion of what the duties of a commission officer are to what powers they have concerning OH&S and the workplace. All of the activities in this section can be tied to the role play initiated in SCO 1.2.1.

Topic 2 Occupational Health and Safety

Suggestions for Assessment

Presentation

- An OH&S officer could be brought into class for a presentation. Students could be given a response form for the presentation, and list the duties and responsibilities for the inspector in question.

Role Play

- Students expand their role play to include the Occupational Health and Safety officer. This rotating role could become part of the committee being used throughout the course.

Resources

WEB

- Occupational Health and Safety Act - http://www.assembly.nl.ca/Legislation/sr/statutes/o03.htm
- Passport To Safety - http://www.passporttosafety.ca/
- Occupational Health and Safety Homepage - http://www.gs.gov.nl.ca/ohs/
- Safework Newfoundland and Labrador - http://209.128.14.165/

Unit 2: Introduction to Engines

Unit 2 Overview

The purpose of this unit is to give students an overview of engines, how long they have been in use and how they have evolved. Power and Energy encompasses more than just the production of energy. It also should deal with the various ways we use energy, and the engine is one of the more revolutionary and pervasive technologies in this area. Basic type of engines have been in use since the fifteenth century, and many of our power production facilities still use processes that are very similar to those early engines.

Within the learning context, the small engine will be the focus of the next unit. The material is based on establishing learning context and information that will form the basis of the learning to follow. Students should have a good understanding of these engine types, and be able to discern the benefits and detriments of each.

Organization

This is unit is organized into a single topic

- Topic 1 - Overview of Engine Development

This topic covers material ranging from the historical development of engine technology to the variety of engine types in common use. There are also discussions around those small engines which have a historical significance to this province and the fishery.

Assessment

This section constitutes approximately 10% of the course time and the value attributed to it should reflect that status.

Topic 1 – Overview of engine development

Specific Curriculum Outcomes

Students will be expected to

2.1.1 summarize the development of external combustion engines [1.404]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to make students aware of the development of engines in history.
External combustion engines separate the heat source from the source of power. In effect, the external heat source heats an internal fluid, through a heat exchanger of some type, which expands, the pressure of which drives a turbine which provides power for use. The process of external combustion is still in use in many power production facilities across the country.

Points to emphasize:

- The two most common types in history are the steam engine and Sterling cycle engine.
  - Steam engines use water as their liquid which heats and condenses in a cycle such that heat energy is lost at each transition
  - The Sterling cycle engine uses air as its liquid, which resolves many of the issues with steam. It is not as dangerous as steam and does not lose as much energy in transition, because it does not transition.

Student Activity:
The Sterling cycle engine is a simplistic version of the external combustion engine that may even be possible to simulate in class. A working model of this engine would be an interesting way of studying it.

Topic 1 – Overview of engine development

Suggestions for Assessment

Paper and Pencil/Research

- Students develop a timeline with the main milestones of steam engine development. Within the timeline a discussion of what impact the Sterling engine could have had on the process of development over time, should be introduced.

Research/Presentation

- Students research the advent of external combustion and the possibilities it had for transportation. Within this research a look into what the present might be without the dominance of internal combustion engines in our transportation system could be undertaken. A poster or short presentation by the students in class would be appropriate.

Resources

TEXT

- *Small Engines,* Third Edition, R. Bruce Radcliff
- *Small Engines Workbook*

WEB

- Operating principles of a Stirling engine - http://en.wikipedia.org/wiki/Stirling_engine
- Advantages of Stirling engines over internal combustion engines - http://engine.stirling.cz/stirling-engine-advantages.html
- How Stirling engines work - http://www.stirlingengine.com/faq#1
- A company producing energy using solar in conjunction with Stirling engines - http://www.tesserasolar.com/
- GrrenPowerScience video featuring Stirling engines and a Fresnel solar lens - http://www.youtube.com/watch?v=fUrB7KRvxUk

Topic 1 – Overview of engine development

Specific Curriculum Outcomes

Students will be expected to

2.1.2 summarize the development of the internal combustion engine [1.404]

Suggested Learning and Teaching Strategies

An internal combustion engine is one in which the explosive combustion of a fuel is used to push a piston within a cylinder - the piston's movement turns a crankshaft that then provides mechanical power for use.

For the purposes of this outcome, the general definition of internal combustion engines is a good beginning, but different types of engines and how internal combustion is used in each will be necessary to give a good view of the whole topic for students.
The common engine types are:

- 2 stroke cycle
- 4 stroke cycle
- Compression (Diesel)
- Rotary
- Rocket
- Jet (Hache)
- Gas Turbines

When discussing the 2 and 4 stroke engines, specific reference should be made to the make and break marine engines commonly used in inshore fishing boats around Newfoundland and Labrador.

Student Activity:
Students could be encouraged to discuss the make and break engine with family members and or older members of the community to find out what the general knowledge about this technology was and is in and around Newfoundland and Labrador.

Topic 1 – Overview of engine development

Suggestions for Assessment

Research/Presentation

- In groups, students outline the aspects that separate the different types of engines, and make presentations to the class on what makes ‘their’ engine different.

Resources

TEXT

- *Small Engines,* Third Edition, R. Bruce Radcliff
- *Small Engines Workbook*

WEB

- Description of the internal combustion engine - http://www.encyclopedia.com/topic/internal-combustion_engine.aspx

Topic 1 – Overview of engine development

Specific Curriculum Outcomes

Students will be expected to

2.1.3 differentiate between internal and external combustion engines [2.404]

Suggested Learning and Teaching Strategies

Within this outcome, the purpose is to show how each of these combustion engine types are different. Essentially it is a case of one has the combustion internal to the motive power being generated and the other has it external. Defining both the types and showing via diagrams what makes each one different would be an excellent way to start.

More importantly though the development of both types of engines over a period of time should be explored. This will show the main technological developments that were required for the advent and expansion of each of the two differing technologies.

Both of these engine types are still in use within society. The basis of many steam - turbine power plants is still the external combustion engines, while the automobile industry is based on the internal combustion engine.

Points to emphasize:

- Technological requirement for internal combustion was later than that for external combustion.
- External combustion has a greater space requirement.

Student Activity:

Students look at the main features of each of the two types of engines and then discuss how each evolved over time. Elements of the previous two outcomes could be brought into this discussion as well.

Topic 1 – Overview of engine development

Suggestions for Assessment

Research/Presentation

- Students look at the differences between the two engine types and the reasons why one gained preeminence over the other as a mode of transportation. A poster or presentation to the class should be completed with this research

Paper and Pencil

- Students compare and contrast the two engine types, taking into account what the benefits are for each. This could be done in the form of a written assignment, a visual or some other form or representation.

Resources

TEXT

- *Small Engines,* Third Edition, R. Bruce Radcliff
- *Small Engines Workbook*

WEB

- Time line of the development of the internal combustion engine - http://www.newworldencyclopedia.org/entry/Internal_combustion_engine

Topic 1 – Overview of engine development

Specific Curriculum Outcomes

Students will be expected to

2.1.4 explain the principles of operation of the major internal and external combustion engine types [2.404]

Suggested Learning and Teaching Strategies

The purpose of this outcome is for students to know the different types of engines and how they operate differently from each other. As preparation you will need to become familiar with the categories of engines and the types of engines within each category. The strengths and weaknesses of each should be discussed and to some extent the era in which they were created.

- External Combustion engines
  - Steam engine
  - Sterling cycle
- Internal Combustion engines
  - 2 stroke cycle
  - 4 stroke cycle
  - Compression (Diesel)
  - Rotary
  - Rocket
  - Jet (Hache)
  - Gas Turbines

Student Activity:
Each of these engines represents the height of technological achievement for their era. Students consider what the future of the engine might look like, and what considerations will be taken into account in its design.

Topic 1 – Overview of engine development

Suggestions for Assessment

Research/Presentation

- Students explain the difference between internal and external combustion engines. This could be done using a series of diagrams and explanations in a presentation or poster.

- Students complete a description of the types of engines in each category of engine. Once again this could be done in poster format, a presentation or a web-based assignment.

Resources

TEXT
- *Small Engines,* Third Edition, R. Bruce Radcliff
- *Small Engines Workbook*

WEB
- Descriptions of how various engine types work - http://www.newworldencyclopedia.org/entry/Internal_combustion_engine
- Animated views of various engine types in operation - http://www.animatedengines.com/co2.shtml

Topic 1 – Overview of engine development

Specific Curriculum Outcomes

Students will be expected to

2.1.5 identify common engine classifications [2.404]

Suggested Learning and Teaching Strategies

This outcome deals with how engines are classified generally and will put together a flow-chart to help in this matter. Just looking at an engine is in some cases enough to be able to determine the classification

The first step of classification is the question of combustion. A quick examination will show whether or not the engine is internal or external combustion. In external combustion a large tank or compression vessel would be necessary to transfer power, while the internal combustion engine is self-contained in that regard. Once this is determined the next steps follow:

- Ignition – compression versus spark ignition. Look for a spark plug, if it is present then it is spark ignited.
- Number of Strokes – 2 stroke or 4 stroke, if the oil is mixed with the gas then it is 2 stroke.
- Cylinder Design – vertical, horizontal, slant, V, opposed, inline. A view of the cyclinders themselves and how they are oriented should show this part.
- Shaft Orientation – vertical or horizontal. If it can easily lay on a table it is horizontal, if a piece sticks out, vertical.
- Cooling System – liquid cooled or air cooled. The presence of a radiator will indicate a fluid-based system.

Student Activity:

Students could use this methodology to examine engines at their home and around their neighbourhood. It is not expected than many external combustion engines will be found but examples of the others should be.

Topic 1 – Overview of engine development

Suggestions for Assessment

Research/Paper and Pencil

- Students develop a flowchart that will result in someone being able to determine the type of engine that are dealing with. This flowchart could be developed into a hand-held identification chart for use in identifying engines.

Research/Presentation

- Students present on each of the steps of the identification process. This will require some research on the topics to help determine the questions to be asked.

Resources

TEXT
- *Small Engines,* Third Edition, R. Bruce Radcliff
- *Small Engines Workbook*

WEB
- Article dealing with the different classifications of engines - http://www.cs.wright.edu/~mawasha/Chapter%201%20Class%20Notes.pdf

Topic 1 – Overview of engine development

Specific Curriculum Outcomes

Students will be expected to

2.1.6 show the principles of operation of a 4 stroke cycle engine [2.404]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to understand the operation of the 4 stroke cycle engine. There are a variety of visual simulations available online that will aid in the teaching of this section. Understanding the 4 stroke cycle is integral to understanding internal combustions engines, their capability, and how important it is that each system work in tandem correctly. Although this is an introduction to how the 4 stroke cycle works, it should also be an opportunity to stress the importance of systems integration and inter-dependability. This basis of understanding is needed as students progress from this section into the breakdown and troubleshooting unit

As the name suggests there are four processes involved in the engine, and the four processes together form a single engine cycle. Those processes are:

- Intake Stroke
- Compression Stroke
- Power Stroke
- Exhaust Stroke

Student Activity:

Using models and diagrams supplied by the teacher, explain the 4 strokes of a 4-stroke engine.

Topic 1 – Overview of engine development

Suggestions for Assessment

Research/Presentation

- Students determine the origins of the 4-stroke cycle engine and how it was developed. A short presentation to the class or a poster on this topic would be appropriate.

Paper and pencil

- Students should outline the process of the 4 strokes. In doing so, they should include drawings and diagrams. This can be either done in an written assignment or as a poster. In that instance, each group of students could take one of the strokes and do a detailed drawing of what occurs.

Resources

TEXT

- *Small Engines,* Third Edition, R. Bruce Radcliff
- *Small Engines Workbook*

WEB

- Animated images of a 4-stroke engine in operation - http://www.animatedengines.com/otto.shtml
- Actual footage inside a four stroke engine - http://www.youtube.com/watch?v=sEf8va1S7Sw
- Motor assembly and operation - http://www.youtube.com/watch?v=mfre1bAKC3o&NR=1&feature=fvwp
- Autoclub - http://www.siu.edu/~autoclub/frange.html
- Fuel Engine Bible - http://www.carbibles.com/fuel_engine_bible.html
- How an engine works - http://www.howstuffworks.com/engine.htm

NOTES

- Appendix A - Notes section pg. 4

Topic 1 – Overview of engine development

Specific Curriculum Outcomes

Students will be expected to

2.1.7 demonstrate the methods used to distinguish between a 2 stroke cycle and 4 stroke cycle gasoline engine [1.405, 2.404]

Suggested Learning and Teaching Strategies

The small engine section within this course will deal primarily with the 4 stroke cycle engine. The next two outcomes deal with comparisons of the two and four stroke cycle engines. The methodology for showing the difference between the two engines is expected to be practical in nature. Students will be shown how to make the determination and then be expected to demonstrate for themselves.
The following methods are useful in this determination:

- Presence of oil filler tube or sump
- Location of exhaust
- Compression method
- Engine name plate or manual (oil ratio/capacity)

The two stroke engine differs from the four stroke essentially in the number of processes that take place in its cycle. A four stroke engine does two up and down motions (4 strokes) of a piston for its cycle, while a two stroke does only one (2 strokes). The beginning of the compression stroke in a two stroke also intakes fuel and air, while the end of the power stroke also exhausts. This allows for twice as many power strokes and allows two stroke engines to give more power for the same weight as a four stroke.

Student Activity:

Students will be able to show the methods used to distinguish between a 2 stroke cycle engine and a 4 stroke cycle engine. This will be accomplished through a teacher led demonstration.

Topic 1 – Overview of engine development

Suggestions for Assessment

Research/Presentation

- Students outline the process of a two stroke engine and present the same to the class. This could be done in front of the class as a formal presentation or in a poster format.

Presentation/Demonstration

- Students demonstrate to the class the various methods for determining whether an engine is a two stroke or a four stroke.

Resources

TEXT

- *Small Engines,* Third Edition, R. Bruce Radcliff
- *Small Engines Workbook*

WEB

- The differences between and the advantages and disadvantages of a 2 stroke versus a 4 stroke engine - http://www.deepscience.com/articles/engines.html
- Two stroke engine cycle - http://en.wikipedia.org/wiki/Two-stroke_engine
- Four stroke engine cycle - http://en.wikipedia.org/wiki/Four-stroke_engine

Topic 1 – Overview of engine development

Specific Curriculum Outcomes

Students will be expected to

2.1.8 compare and contrast the service life of a 4 stroke versus a 2 stroke cycle internal combustion engine [1.405, 2.404]

Suggested Learning and Teaching Strategies

The service life of any engine can be summarized as a period of break-in when the engine runs less efficiently due to parts wearing in. Then there is a period when the parts are worn to a point of being better mated with their counter-parts and the engine runs at its peak efficiency. Finally as the parts continue to wear they reach a point where the engine performs less efficiently. You are now entering the last part of the service life of an engine. Less efficient operation is a sign that the engine wear is approaching critical stages. In a larger engine parts would be replaced and repaired extending its life. In smaller engines, these replacement and repairs can only extend things so far as the cost of replacement of the entire engine is sometimes less than repair and replacement of certain parts.
This is known as the life cycle.

When comparing a 2 stroke and 4 stoke cycle engine it should be noted that 2 stroke cycle engines have a shorter service life due to a variety of factors, the most commented on being insufficient lubrication due to a lack of a dedicated lubrication system.

Student Activity:
Students should consider life-cycle along with the term planned obsolescence. Although in most cases small engines do not fall into this category, the devices they are used in do.

Topic 1 – Overview of engine development

Suggestions for Assessment

Research/Presentation

- Students produce a poster that describes the service life of a 4 stroke cycle engine.
- Students research life cycles of devices and the factors that will shorten or lengthen cycles. These factors should be compared to examples of best-practices for care and storage of those devices.

Resources

TEXT

- *Small Engines,* Third Edition, R. Bruce Radcliff
- *Small Engines Workbook*

WEB

- The advantages and disadvantages of a 4 stroke versus a 2 stroke - http://www.deepscience.com/articles/engines.html

Unit 3: Experiencing Small Engines Modularly

Unit 3 Overview

The purpose of this unit is to provide students with hands-on experience with small engines. Each student group will be working with an engine and performing a structured breakdown of the various systems. As well some of the more common problem sections will be enhanced through the use of troubleshooting experiences and experiential activities to enhance understanding and learning.

Although this section is not strictly modular in approach, it does present the information in a fashion that would allow structured modules to be used. Otherwise each of the engines is assigned to a group for the whole of learning time. It is expected that one half of the course time will be spent on the small engines section and one half spent on the following units in alternative energy. This will allow for a split arrangement within the fabrication lab.

Organization

The following unit topics will provide these experiences:

- Topic 1: Small Engine Overview
- Topic 2: Ignition Systems
- Topic 3: Fuel Systems
- Topic 4: Valve Train/Timing System
- Topic 5: Compression System
- Topic 6: Lubrication/Cooling System
- Topic 7: Mechanical System

These topic areas encompass important parts of the curriculum dealing with small engine repair and troubleshooting. They are intended to be almost purely practical and experiential in nature. Hands-on activities should be the norm in this unit.

Assessment

This section constitutes approximately 40% of the course time and the value attributed to it should reflect that status. It is expected that most of the assessment opportunities in this section will involve hands-on activities and assessment tools dealing with observation and experiential learning will be the most effective.

Topic 1 – Small Engine Overview

Specific Curriculum Outcomes

Students will be expected to

3.1.1 define the process of troubleshooting as a problem solving tool [1.402, 1.404, 2.404]

Suggested Learning and Teaching Strategies

Troubleshooting processes are systematic, and when followed will give students a path to follow to solve problems in almost any situation. This outcome deals specifically with troubleshooting small gas engines, and thus will involve steps in the process specific to that.

Troubleshooting techniques are closely related to the design process, and can be laid out in the same fashion, as a flow-chart. Effective troubleshooting isolates the problem by system, and asks questions at each point.

A variety of troubleshooting techniques can be found in common places, most all troubleshooting sections of user manuals will use the question-response technique. If this is the case then this is probably what is wrong, or this is the first place you should look.

For example

Engine doesn't start.

- Is the ignition system engaged?
- Is there fuel in the tank?
- Is there a spark coming from the spark plug?

These are three quick questions that come out of the stated situation. In this way a series of troubleshooting charts can be created. These will tell the individual where to start and which systems to isolate for further study.

Topic 1 – Small Engine Overview

Suggestions for Assessment

Research/Practical Activity

- Students research a variety of user manuals for engine run devices or appliances and identify examples of troubleshooting charts within them. These can then be shared in the class as a whole.

Paper and Pencil/Research

- Students develop their own troubleshooting chart template that can be used in the later outcomes for their own use in the small engine section. These can be accentuated through online research.

Resources

TEXT

- *Small Engines,* Third Edition, R. Bruce Radcliff
- *Small Engines Workbook*

WEB

- Troubleshooting - http://en.wikipedia.org/wiki/Troubleshooting
- General Troubleshooting Theory - http://www.peachpit.com/articles/article.aspx?p=420908&seqNum=2
- The ten step Universal Troubleshooting Process - http://www.troubleshooters.com/tuni.htm#_The_10_step_Universal_Troubleshooting
- Basic Approaches to troubleshooting -http://www.juniper.net/techpubs/software/junos/junos42/swcmdref42/html/strategies2.html
- Briggs & Stratton site with sample troubleshooting flow charts - http://www.thepowerportal.com/Login.htm?

MATERIALS:

- Service manual for specific engine

Topic 1 – Small Engine Overview

Specific Curriculum Outcomes

Students will be expected to

3.1.2 identify the six basics systems of a 4 stroke cycle gasoline engine [2.404]

Suggested Learning and Teaching Strategies

All engines can be broken down into a series of systems. These systems act together to make the engines run correctly and smoothly. When one is not functioning correctly these are issues that may effect more than one of the systems. Students should be able to correctly identify some of the systems within engines with or without prompting.

A brainstorming session at this time would be an effective way of introducing this topic, asking students what the different systems on a 4 stroke engine are. Commonly the answers expected might include:

- Exhaust system
- Ignition
- Fuel

For the purposes of this course, the six systems that will be studied will be:

- Ignition
- Fuel
- Compression
- Mechanical
- Lubrication/Cooling
- Valve train/timing

Student Activity:

Students do some examination of these systems on various motors at home. It is suggested that this examination remain as observation in this instance.

Topic 1 – Small Engine Overview

Suggestions for Assessment

Research/Presentation

- Each student group take one of the systems discussed and research its purpose in the engine. This research could be presented to the class or done as a poster.

Research

- Students research the various systems and look at their evolution over time. A comparison of what the fuel system looked like in an older style engine (leaded gas) as compared to the newer system (unleaded gas)

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs and Stratton Power Portal - http://www.thepowerportal.com/Login.htm?
- How to repair small engines - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines.htm
- Small Engine Repair Text - http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/32/25/e7.pdf
- Engine Overview - http://www.tpub.com/engine3/index.htm

MATERIALS

- Service manual our specific engine
- Engine for examination

Topic 1 – Small Engine Overview

Specific Curriculum Outcomes

Students will be expected to

3.1.3 identify common troubleshooting techniques for 4 stroke cycle engines [1.402, 1.404, 2.404]

Suggested Learning and Teaching Strategies

Troubleshooting, as discussed before, is an important methodology for students to use in their work on small gas engines. There are a variety of ways that students can carry this forward, up to and including developing their own troubleshooting chart. But troubleshooting charts have already been developed for everything from the most common gasoline engines to the most obscure.

Most engine manufacturers have developed some sort of troubleshooting chart, with suggestions of which sub-system may be involved in the problem. A troubleshooting chart will is used to establish a place to start. Students should practice identifying a problem specifically and in the form of a direct statement. “It won’t start” is not specific enough to carry through a chart process of this type. Students need to be more specific, like the “engine does not turn over” or “the pull cord will not pull out” or “the engine turns over but will not engage”. Specificity is the watchword in this instance.

As well the first steps on most charts would be to drain oil or gasoline, or check the fuel line. All of these methods will require that the students be prepared for what each stage of the process will entail. Set-up is the first step. Gather tools and equipment necessary to perform a tear-down of an engine. These will be more familiar after students work through the practical activities to follow.

Student Activity:

Students should search out the specific troubleshooting chart for the engine they are to work on.

Topic 1 – Small Engine Overview

Suggestions for Assessment

Research/Paper and pencil

- Students should compare the chart template they developed in the beginning of this unit, to the chart that is specific to their engine. Both of these could then be compared to a generic chart found on the internet. Through this work students should be able to develop a more complete template for their chart.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton site with sample troubleshooting flow charts - http://www.thepowerportal.com/Login.htm?
- Basic Approaches to troubleshooting -http://www.juniper.net/techpubs/software/junos/junos42/swcmdref42/html/strategies2.html
- The ten step Universal Troubleshooting Process - http://www.troubleshooters.com/tuni.htm#_The_10_step_Universal_Troubleshooting
- Troubleshooting flowchart - http://www4.briggsandstratton.com/display/router.asp?DocID=66994

Topic 2 – Ignition Systems

Specific Curriculum Outcomes

Students will be expected to

3.2.1 locate appropriate sections of the manufacturer's service manual, dealing with the ignition system on a 4 stroke cycle engine [2.404]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to familiarize and to enable students to use manufacturer's service manuals. All of the information needed to work on a small engine is found in this guide.

Service technicians must have a solid grounding in the reference materials provided by manufactures. Students will explore the ignition information contained in a sampling of these references. Engine manufacturers use model numbers that encodes engine specifications about the various systems used on a given engine. Students should be able to decode this information.

Students should be able to identify the:

- spark plug type
- ignition system type
- flywheel type

from the manual provided. A check that this manual is the proper one of the engine in question should also be undertaken.

Student Activity:
Provide students with the reference materials specific to the engine brand being used in class. Students can use these reference materials to decode the information used in the engine model number.

Topic 2 – Ignition Systems

Suggestions for Assessment

Research

- Students research the version of the manual they are using to ensure that it is the most up to date available.

Research Assignment

- Students research other manuals from other engine manufacturers and compare how they are laid out, the language used and the diagrams. These commonalities or differences could be itemized in a written assignment or recorded in their work log.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs and Stratton Support Site - http://www.thepowerportal.com/Login.htm?
- To locate owner's manual according to engine model number - http://www4.briggsandstratton.com/display/router.asp?docid=67021
- Small Gas Engines site - http://www.smallenginesuppliers.com/
- Maintenance and repair Manual - http://www.briggsandstratton.com/maint_repair/manual_and_more/

MATERIALS

- Service manual for specific engine

Topic 2 – Ignition Systems

Specific Curriculum Outcomes

Students will be expected to

3.2.2 demonstrate knowledge of terms and tools used in the industry for ignition systems of a 4 stroke cycle engine [1.405]

Suggested Learning and Teaching Strategies

This outcome will help students identify the tools necessary to service /repair the ignition system. Proper terminology will enable students to be able to identify parts and functions more readily from manufacturers' documentation. It is suggested to cover the terms first and the tools in specific reference to their use and corresponding part of the ignition system. To this end, the terms are listed first below. This list of ignition terms is not all-inclusive but is sufficient for the tasks at hand.

Ignition terms:

- armature
- primary windings
- secondary winding
- magnets
- breaker points
- primary circuit
- secondary circuit
- condenser (capacitor)
- spark plug
- terminal
- center electrode
- insulator
- shell
- ground (side electrode)
- reach
- heat range
- hot spark plug
- cold spark plug
- pre-ignition
- ignition coil
- Silicon Controlled Rectifier (SCR)
- stop switch

Students should have a broad-based understanding of these terms, and should review them and use them in class an in practical activities.

Topic 2 – Ignition Systems

Suggestions for Assessment

Research/Paper and pencil

- Students research the basis for some of the terms and tools used in this section. This could be done in a written report or presentation to the class.

Work Log/Portfolio

- Students start keeping a list of all the terms in each of the sections. These terms will be defined in the work log. They could be accompanied by images or drawings to indicate what the term refers to in the ignition assembly.

- Students start keeping a list of all the tools they come in contact with in each of the sections. These tools will be described in the work log, accompanied by images or drawings to indicate what the tool does, and how it is used.

Research/Presentation

- Students research the origin and previous versions of the tools they are learning about in this section. They compare the "older" tool type to the new and improved type , attempting to see why the improvement was made. This information could be presented to the class as a whole or as a poster.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Automotive dictionary - http://www.motorera.com/dictionary/ig.htm ()
- Tool catalog - http://www.thepowerportal.com/Login.htm? (will find tool catalog here)
- How to use a multimeter - http://www.wikihow.com/Use-a-Multimeter
- How to use a multimeter - http://a248.e.akamai.net/pix.crutchfield.com/ca/learningcenter/car/pdfs/000multi2.pdf
- Pocket rpm tester - http://www.treysit.com/TREYSIT_Sirometer__revolution-/treysit_sirometer__revolution-.html

MATERIALS

- Service manual for specific engine

Topic 2 – Ignition Systems

Specific Curriculum Outcomes

Students will be expected to

3.2.2 demonstrate knowledge of terms and tools used in the industry for ignition systems of a 4 stroke cycle engine [1.405] (cont'd)

Suggested Learning and Teaching Strategies

Each of the ignition tools listed below has a specific purpose for the ignition system. Some will have roles in other tear down activities, but for the most part are only used for the purpose their name describes.

Ignition tools:

- feeler gauge
- spark plug tester (ignition tester)
- spark plug wrench
- starter clutch wrench
- strap-type flywheel holder
- torque wrench
- dial bore gauge
- multimeter
- engine tachometer

Students should not only be able to identify the purpose of the tool in question, but be able to recognize and manipulate the tool to some extent. The use of specific tool demonstrations in this section would be indicated.

Student Activity:

Students do some activities to help them remember the name of each tool and its purpose. Linking the name to the purpose would be most effective and easy in some of the cases.

Topic 2 – Ignition Systems

Suggestions for Assessment

Research/Presentation/Paper and pencil

- Students do a tool chart or a series of tool posters with an image of the tool, its proper name and its use in the tear down of a small engine. It could be done in groups with the posters displayed around the room, or as a chart containing all the tools done by each group.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Automotive dictionary - http://www.motorera.com/dictionary/ig.htm ()
- Tool catalog - http://www.thepowerportal.com/Login.htm? (will find tool catalog here)
- How to use a multimeter - http://www.wikihow.com/Use-a-Multimeter
- How to use a multimeter - http://a248.e.akamai.net/pix.crutchfield.com/ca/learningcenter/car/pdfs/000multi2.pdf
- Pocket rpm tester - http://www.treysit.com/TREYSIT_Sirometer__revolution-/treysit_sirometer__revolution-.html

MATERIALS

- Service manual for specific engine

Topic 2 – Ignition Systems

Specific Curriculum Outcomes

Students will be expected to

3.2.3 state the function of the ignition system in small gas engines [2.404, 3.401]

Suggested Learning and Teaching Strategies

Within an automobile an "ignition" is the system including the key which "starts" the engine. It could be said to "ignite" and start the process of combustion. The true nature of an ignition is more involved than that. The purpose of the ignition system on small gas engine is to deliver an ignition spark to the air fuel charge at the correct moment to produce the maximum amount of downward force to produce power. The system then does not initiate the process so much as it is part of the cycle of the 4 stroke cycle engine.

Within a small engine-ignition system there are:

- the ignition controller
- spark plugs
- flywheel
- wiring

There are different ignition system types and these will be discussed in the next outcome, but generally although the methodology may be different the outcome is the same.

Student Activity:

Students familiarize themselves with different types of ignition systems, beyond those used by small engines. An observation of the ignition system of a full size vehicle could be undertaken without too much trouble and little risk.

Topic 2 – Ignition Systems

Suggestions for Assessment

Research/Paper and pencil

- Students research ignition systems from the past and how they have evolved. This will involve review of the initial systems on the very first engines, and looking at the technological advances that have allowed for changes in the base system. This can be done as a written assignment.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton support site - http://www.thepowerportal.com/Login.htm?
- How to repair small engines - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines.htm
- How an ignition works - http://www.ehow.com/how-does_5554761_small-gas-engine-ignition-works.html
- How primary coil works - http://www.ehow.com/how-does_5579871_primary-gas-engine-ignition-system.html
- Ignition System function - http://www.answers.com/topic/ignition-system-1
- Parts of ignition system - http://www.wisegeek.com/what-are-the-parts-of-an-ignition-system.htm
- Magento system and history - http://en.wikipedia.org/wiki/Ignition_system
- Reading Briggs and Stratton Engine codes - http://www.scribd.com/doc/25153865/Briggs-Stratton-Small-Gas-Engine-Service-Maintenance
- Spark plugs - http://auto.howstuffworks.com/spark-plugs2.htm

MATERIALS

- Service manual for specific engine

Topic 2 – Ignition Systems

Specific Curriculum Outcomes

Students will be expected to

3.2.4 compare and contrast the three most common types of ignition used on small gas engines [2.404, 3.401]

Suggested Learning and Teaching Strategies

As discussed in the previous outcome, there are many different types of ignition systems used with small gasoline engines. The three most common in current use are:

- Magneto ignition
- Capacitive Discharge ignition (Solid State)
- Battery ignition

Each of these systems generates an extremely high voltage (20,000 volts). The voltage causes a spark to jump across the spark plug's gap, and the spark ignites the fuel in the engine. How they generate the voltage in the first place is the main difference.

Most of the small engines in use today use one of the following ignition systems listed. It should be noted that the Magneto system is the oldest and is currently being replaced by the more reliable solid state (CDI) ignition system.

Student Activity:

Students examine common engine-using devices in and around their home to identify what they think is the ignition system in use. They should be able to find at least two of the types listed above (a car and lawn mower). This is an opportunity to engage them in a discussion of why certain types are used in certain places.

Topic 2 – Ignition Systems

Suggestions for Assessment

Research/Presentation

- Students could, in groups, take one of the ignition types listed and do a presentation to the class on how it works, where it is used and what other applications it has.

- Students research the future of ignition technology. These future options could be presented to the class in the form of a poster or a formal presentation. Discussions of possible limitations, time frames when they would be seen, and applications could also take place.

Research/Paper and pencil

- Students research other types of ignition systems, not identified in this unit, and do a report on the reasons why they are not more popular and whether or not they offer better solutions than the ones listed.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- History & types - http://en.wikipedia.org/wiki/Ignition_system
- Magneto type ignition - http://en.wikipedia.org/wiki/Magneto
- How a solid state ignition works - https://lookup3.toro.com/ttcGateway/acrobat/manuals/lball26.pdf ()
- Capacitor discharge ignition - http://en.wikipedia.org/wiki/Capacitor_discharge_ignition
- CDI Ignition - http://www.gill.co.uk/products/digital_ignition/Introduction/3_CDI_ignition.asp
- Battery ignition systems - http://www.tpub.com/content/armyordnance/OD1003/OD10030056.htm

MATERIALS

- Service manual for specific engine

NOTES

- Appendix A - Notes section pg. 5

Topic 2 – Ignition Systems

Specific Curriculum Outcomes

Students will be expected to

3.2.5 measure ignition system components with the appropriate industry measurement tools [2.401, 2.404]

Suggested Learning and Teaching Strategies

Each section of the small engine has to be properly aligned and set up to allow for smooth and proper operation. As students work through tear downs they need to be able to experience what measurements have to be taken and how those measuring devices operate. The best way for this to occur is for students to use these measuring devices when they are doing their tear down. Experiential learning is the most effective method for learning the use of tools and measuring devices in most cases, so covering this outcome with the section on tear down would be appropriate.

Students should be able to identify and use tools to accurately measure ignition specifications. For the most part the ignition system has the following measurements to be taken:

- Plug gap
- Point gap
- Armature air gap

In most cases the feeler gauge is the tool for the measurements. But the micrometer and caliper can be used to measure spark gap.

Student Activity:

Students expand on this section by doing some research into high performance and how changing some of the measurements listed above will affect performance for the better or the worse.

Topic 2 – Ignition Systems

Suggestions for Assessment

Practical Activity

- Students practice their use of the individual measuring tools used in this section by measuring objects with known measurement values. The results the students obtain could then be compared to a known standard and in this way mastery could be determined.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Setting spark gap - http://www.youtube.com/watch?v=lk70oyUEftY
- How to use a feeler gauge - http://en.wikipedia.org/wiki/Feeler_gauge
- How to use a feeler gauge - http://www.ehow.com/how_4962698_use-feeler-gauge.html
- Setting Air armature gap - http://www.tpub.com/content/recoveryvehicles/TM-5-4240-501-14P/css/TM-5-4240-501-14P_85.htm
- Setting points gap - http://www.youtube.com/watch?v=9D4oKW0mXBs
- Briggs and Stratton resource site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine

TOOLS

- Briggs & Stratton spark testing Tool 19368
- Feeler gauge
- Spark plug wrench

Topic 2 – Ignition Systems

Specific Curriculum Outcomes

Students will be expected to

3.2.6 demonstrate and perform the proper procedure/ tools used in the examination of the ignition system [2.401, 2.404]

Suggested Learning and Teaching Strategies

This section is intended to be completed as an practical/ hands-on activity. Students will need to kinesthetically learn the processes that are involved in each of the following steps of examining an ignition system. Although learning the terms and names and uses of tools was to be done in the previous section, some of this work can be done in concert with this outcome.
Students will perform the procedures outlined in the notes section to assess the performance of the ignition system. Students must be encouraged to begin with the easiest test to complete and then work up to more complicated procedures.

Sometimes the simplest things cause the problem, such as wires cut or disconnected.

The process to be followed is similar to other models of examination of problem areas and can be directly related to methods of troubleshooting and repair.

Student Activity:

Students complete the procedures for examination of an ignition system. This can be incorporated into a research assignment where students write out each step and then perform each. A checklist could be developed to confirm that each procedure is completed by the students.

Topic 2 – Ignition Systems

Suggestions for Assessment

Practical Activity

- Students practice the use of tools necessary for the examination of an ignition system. They could demonstrate their capability for the teacher.

Research/Presentation

- Students take one process or series of processes for the examination of an ignition system and outline the proper use and what is germane. This could be presented to the class as a whole or as a poster.

Paper and pencil/Demonstration

- Students be able to demonstrate that they can use these tools safely. This is tied specifically into the first unit of the course. All of these tools need to be qualified for through demonstration and written safety quizzes.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- How spark tester works - http://www.ehow.com/how-does_4885694_spark-plug-tester-work.html
- Checking for spark - http://techauto.awardspace.com/ignition.html
- Ignition system theory - http://engines.myfaqcenter.com/Answer.aspx?p_faqid=3761&body_0$tbKeyword=wiring
- Briggs and Stratton support site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine

TOOLS

- Briggs & Stratton spark testing Tool 19368
- Feeler gauge
- Spark plug wrench
- Correct flywheel holder
- Correct flywheel puller

NOTES

- Appendix A - Notes section pg. 6

Topic 2 – Ignition Systems

Specific Curriculum Outcomes

Students will be expected to

3.2.7 complete a tear down and re-assembly of a 4 stroke cycle ignition system [2.401, 2.404]

Suggested Learning and Teaching Strategies

This outcome is a practical activity. Each student group should be given one engine that will be theirs for the rest of the activities.

Students will disassemble/reassemble the following ignition system components.

- Magneto ignition
- Capacitive Discharge ignition
- Battery ignition
- Armature
- Primary windings
- Secondary winding
- Magnets
- Primary circuit
- Secondary circuit
- Condenser (capacitor)
- Spark plug
- Terminal
- Center electrode
- Insulator
- Shell
- Ground (side electrode)
- Reach
- Heat range
- Hot spark plug
- Cold spark plug
- Pre-ignition
- Ignition coil
- Silicon Controlled Rectifier (SCR)
- Stop switch

Student Activity:

Students should be prepared to reassemble their engine after the completion of this activity, keeping this in mind throughout the tear-down section.

Topic 2 – Ignition Systems

Suggestions for Assessment

Practical Activity

- Students perform a tear down of a small gas engine ignition system. This should be done while ensuring that reassembly will be easily accomplished.

Research/Practical Activity

- Students refer to the manufacturer's script on tear-down and develop a proper sequencing for the tear-down of an ignition system

Research/Discussion

- Students research the methods for breakdown of different ignition systems (those not used on the engine in question) and discuss with the remainder of the class the differences in question.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- How to repair small engines - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines3.htm
- Briggs and Stratton support site - http://the powerportal.com

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials
- Briggs & Stratton power points provided with course materials.

Topic 2 – Ignition Systems

Specific Curriculum Outcomes

Students will be expected to

3.2.8 using a variety of troubleshooting techniques identify an ignition system problem on a malfunctioning 4 stroke cycle engine {1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

As discussed in an earlier section troubleshooting processes are systematic, and when followed will give students a path to follow to solve problems in almost any situations. This outcome deals specifically with troubleshooting small gas engines ignition systems, and thus will involve steps in the process specific to that.

The ignition system has specific problems associated with it, but as the example that was used in the first section, most of them involve:

- the engine not starting,
- misfiring, or
- not fully burning the fuel in the process

There may be more than this but these are three that can be specifically attributed to the ignition system. A problem for the whole engine has to be isolated to a single system to tell the individual where to start and which systems to isolate for further study.

Student Activity:

Students will reference the engine manual to find trouble shooting information. Manufactures often provide troubleshooting charts to help identify problem situations and suggest a means to rectify each.

Topic 2 – Ignition Systems

Suggestions for Assessment

Practical Activity

- Students undertake a troubleshooting process on a malfunctioning small gas engine. This malfunction should be centred on the ignition system. Students will be expected to identify the problem and the steps they used in the process.

Research/Presentation

- Students refer to the manufacturers troubleshooting section dealing with ignition systems. A comparison of what the manufacturers guide says to what was actually undertaken could be done at this point. A presentation to the class on the differences or a short discussion could result.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- How to repair a small engine - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines.htm
- Troubleshooting small gas engines - http://www.diygokarts.com/engine/small-engine-troubleshooting.html
- Small engine repair - http://www.m-and-d.com/helpfaq.html
- Troubleshooting ignition systems - http://www.ehow.com/how_5700376_troubleshoot-small-engine-ignition.html
- Briggs and Stratton support site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials
- Briggs & Stratton power points provided with course materials.

Specific Curriculum Outcomes

Students will be expected to

3.2.9 using proper tools and procedures solve an ignition system problem on a malfunctioning 4 stroke cycle engine [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

This outcome is intended to be completed with the previous outcome and after student groups have completed their tear down section. A series of engines, not involved in the tear down section, should be available for this outcome. These engines should be in good working order before this outcome is undertaken. It is suggested that these engines be prepared to simulate ignition problems. This is also necessary for the previous outcome. Students could troubleshoot the problem, attempting to identify it from their processes, and then correct it using the proper techniques learned in the previous sections.

Although this troubleshooting section is placed at the end of this topic and other topics to come, it is possible to separate out the troubleshooting of each topic and have it as a stand-alone module, This would allow for students to do troubleshooting without knowledge of which engine system they are dealing with. It would also increase the number of modules in this section.

Student Activity:
Students will be required to diagnose engine problems and using the tools provided correct each. Engines should be in working condition when the task is completed.

Suggestions for Assessment

Practical Activity

- Students could, using proper tools and procedures, solve an ignition system problem on a malfunctioning 4 stroke cycle engine.

Research/Discussion

- Students research the most common problems of the 4 stroke cycle engine. They acquire what statistics are available and share these with the class in a discussion format.

Work Log/Portfolio

- Students outline the procedure they used to solve their engine problem.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- How to repair a small engine - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines.htm
- Troubleshooting small gas engines - http://www.diygokarts.com/engine/small-engine-troubleshooting.html
- Small engine repair - http://www.m-and-d.com/helpfaq.html
- Troubleshooting ignition systems - http://www.ehow.com/how_5700376_troubleshoot-small-engine-ignition.html
- Briggs and Stratton support site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials
- Briggs & Stratton power points provided with course materials.

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.1 locate appropriate sections of the manufacturer's service manual, dealing with the fuel system on a 4 stroke cycle engine [2.404]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to familiarize and enable to students to use manufacturer's service manuals. All of the information needed to work on a small engine is found in this guide.

Service technicians must have a solid grounding in the reference materials provided by manufactures. Students will explore the fuel system information contained in a sampling of these references. Engine manufacturers use model numbers that encodes engine specifications about the various systems used on a given engine. Students should be able to decode this information.

Students should be able to identify the:

- carburetor type
- fuel type
- whether the fuel system is filtered or non-filtered

from the manual provided. A check that this manual is the proper one for the engine in question should also be undertaken.

Student Activity:
Students study the section in the service manual that relates to the maintenance and repair of the fuel system.
Included in this study students will become familiar with the principles of carburetors in small engines.

Topic 3 – Fuel Systems

Suggestions for Assessment

Research

- Students research the current manual they are using to ensure that it is the most up to date available.

Research Assignment

- Students research manuals from other engine manufacturers and compare how they are laid out, the language used and the diagrams. These commonalities or differences could be itemized in a written assignment.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.2 demonstrate knowledge of terms and tools used in the industry for fuel systems of a 4 stroke cycle engine [1.405]

Suggested Learning and Teaching Strategies

This outcome will help students identify the tools necessary to service /repair the fuel system. As well, the use of proper terminology will enable students to be able to identify parts and functions more readily from manufacturers' documentation. It is suggested to cover the terms first and the tools in specific reference to their use and corresponding part of the fuel system. To this end, the terms are listed first below. This list of fuel system terms is not all-inclusive but is sufficient for the tasks at hand.

Students will be able to define the following terms:
- Carburetor
- Gas tank
- Main fuel adjustment screw
- Idle Fuel adjustment screw
- Idle screw
- Throttle Plate
- Choke plate
- Venture
- Fuel inlet valve
- Float
- Float bowl
- Diaphragm
- Primer
- Needle valve
- Air vane governor
- Centrifugal (mechanical)

Students should have a broad-based understanding of these terms and should review them and use them in class and practical activities.

Topic 3 – Fuel Systems

Suggestions for Assessment

Research/Paper and pencil

- Students research the background for some of the terms and tools used in this section. This could be done in a written report or presentation to the class.

Work Log/Portfolio

- Students start keeping a list of all the terms in each of the sections. These terms could be defined in the work log, accompanied by images or drawings to indicate what the term refers to in the fuel system.

- Students start keeping a list of all the tools they come in contact with in each of the sections. These tools could be described in the work log, accompanied by images or drawings to indicate what the tool if for, and how it is used.

Research/Presentation

- Students research the origin and previous versions of the tools they are learning about in this section. They could compare the "older" tool type to the new and improved type , attempting to see why the improvement was made. This information could be presented to the class as a whole or as a poster.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Basic small engine terminology - http://www.jdpower.com/autos/articles/Basic-Engine-Terminology
- Terms / principles - http://en.wikipedia.org/wiki/Four-stroke_engine
- Fuel system components - http://www.autoeducation.com/autoshop101/fuel.htm
- Fuel system components - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines.htm

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.2 demonstrate knowledge of terms and tools used in the industry for fuel systems of a 4 stroke cycle engine [1.405]

(cont'd)

Suggested Learning and Teaching Strategies

Each of the tools listed below has a specific purpose for the fuel system. Some will have roles in other tear down activities, but for the most part are only used for the purpose their name describes.

Tools:
- Carburetor adjustment tool
- Flat top screwdriver
- Socket wrench with driver

Students should not only be able to identify the purpose of the tool in question, but be able to recognize and manipulate the tool to some extent. The use of specific tool demos in this section would be indicated.

Student Activity:

Students do some activities to help them remember the name of each tool and its purpose. Linking the name to the purpose would be most effective and easy in some of the cases. As well students should be able to recognize the general nature of some of the tools they are using and the multiple uses to which they may be applicable.

Topic 3 – Fuel Systems

Suggestions for Assessment

Research/Presentation/Paper and pencil

- Students prepare a tool chart or a series of tool posters with an image of the tool, its proper name and its use in the tear down of a small engine. It could be completed in groups with the posters displayed around the room, or as a chart containing all the tools covered by each group.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Basic small engine terminology - http://www.jdpower.com/autos/articles/Basic-Engine-Terminology
- Terms / principles - http://en.wikipedia.org/wiki/Four-stroke_engine
- Fuel system components - http://www.autoeducation.com/autoshop101/fuel.htm
- Fuel system components - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines.htm

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- carburetor adjustment tool
- flat top screwdriver
- socket wrench

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.3 differentiate between the methods used to supply fuel in small gas engines [2.404, 3.401]

Suggested Learning and Teaching Strategies

The fuel system in most gasoline engines can be broken down into a series of component systems:

- Fuel storage
- Fuel transfer
- Fuel/air filtering
- Fuel injection into cylinders

In the following outcomes, each of these component systems will be separated and defined to differentiate between the different models of small gasoline engines. The first one we will cover will be the fuel transfer system.

In fuel transfer there are three basic methods available to transfer the gas from the storage (tank) to the next system in the process (carburetor). These three methods are

- Gravity feed
- Suction feed
- Pressure feed

This section should involve demonstrations of how each system could work. As well, practical views of where the system is on the engine and which one is specifically in use on the engines we are using would also be useful.

Student Activity:

Students identify through observation and research what system is used for fuel transfer on common engine-run machinery at their home. This information could be brought back to the class as a whole for discussion on the reasons why each one is used in the specific situation.

Topic 3 – Fuel Systems

Suggestions for Assessment

Research/Presentation

- Students research the most common method for fuel transfer in a small gasoline engine and the reasons why it has become the most popular. This could then be presented or discussed with the class as a whole.

Research/Paper and pencil

- Students research the history of fuel transfer in small gasoline engines, itemizing the changes made over time in an assignment.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton site http://thepowerportal.com
- Carburetor defined, history, principle of operation - http://en.wikipedia.org/wiki/Carburetor
- How a carburetor works - http://auto.howstuffworks.com/question377.htm
- Small engine carburetors - http://computerizedenginecontrols.co.cc/small-engine-carburetors

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials
- Briggs & Stratton power points provided with course materials.

NOTES

- Appendix A - Notes section pg. 7

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.4 compare and contrast the three types of carburetors used in small gas engines [2.404, 3.401]

Suggested Learning and Teaching Strategies

The next system to be looked at in our examination of the fuel system is the system which injects the fuel into the cylinders. In larger and newer gas engines, this is actually a fuel injection system, electronic in nature that shoots a rich fuel air mix into the cylinders. In small gas engines though, for the most part, this is done with a device called the carburetor. The carburetor is responsible for mixing gas and air together for entry into the cylinder so that the 4 cycle process can happen.

The three types of carburetors we will be looking at are:

- Float Carburetor
- Vacuum Carburetor
- Diaphragm Carburetor

Once again, viewing the type of carburetor that is used on the engine in questions is an excellent practical way of introducing this section. Discussion of why types of carburetor are used in certain situations.

Student Activity:

Students discuss in small groups or the whole class, why carburetors are no longer the norm in automobiles and why electronic fuel injection has become the rage.

Topic 3 – Fuel Systems

Suggestions for Assessment

Paper and pencil

- Students compare and contrast the three common types of carburetors in a written assignment, outlining the strengths and weaknesses of each

Research/Presentation

- Students research the history of carburetors, where they came from and why they were developed. This could be either presented to the class or in a poster.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Carburetor defined, history, principle of operation - http://en.wikipedia.org/wiki/Carburetor
- How a carburetor works http://auto.howstuffworks.com/question377.htm
- Small engine carburetor - http://computerizedenginecontrols.co.cc/small-engine-carburetors
- How a carburetor works - http://www.youtube.com/watch?v=zUuVQfvWSnI
- Float type carburetor defined - http://www.answers.com/topic/float-type-carburetor
- Carburetor: basic principles - http://www.thisoldtractor.com/gtbender/mg_manuals/dellorto_manual.pdf

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

NOTES

- Appendix A - Notes section pg. 7

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.5 discuss the differences between the two main types of governors used in small gas engines [2.404, 3.401]

Suggested Learning and Teaching Strategies

A governor is a device used on a small gas engine to control the speed as the load on it changes. As the load slows an engine down, the governor is the device that increases the throttle to keep the speed more constant. This is generally more of an issue on such things as generators but has utility in many small gas engines.

We will be looking at two types of governors:

- Mechanical governor
- Air vane Governors

In either case, governors are complex devices and most do-it-yourself web sites send the would-be adjuster directly to the manufacturers manual for information. Viewing the governor in use on the engine that will be studied in class may give students a better understanding of why it is so complex and difficult to work with.

Student Activity:

In this case students research other items that require governors and how they are used. This can be done through devices in their home or ones they may have worked with or seen. A small group discussion or class discussion on how and why governors are used could also ensue.

Topic 3 – Fuel Systems

Suggestions for Assessment

Research/Presentation

- Students research the most common type of governor used in small gasoline engines and the reasons why is has become the most popular. This could be presented to the class as a whole or on a poster for placement in the fabrication lab.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Governors defined/described - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines.htm
- Briggs & Stratton resource site - http://thepowerportal.com
- Tips and guidelines - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines2.htm
- Air vane governors explained - http://www.tpub.com/content/recoveryvehicles/TM-5-4240-501-14P/css/TM-5-4240-501-14P_142.htm
- Centrifugal/mechanical governor - http://en.wikipedia.org/wiki/Centrifugal_governor

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

NOTES

- Appendix A - Notes section pg. 7

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.6 describe the three types of air cleaners used in small gas engines operate [1.405, 2.404, 3.401]

Suggested Learning and Teaching Strategies

For the purposes of this outcome an air cleaner (also known as an air filter) is a device that removes impurities and particulates from the air because the processes the air is required for need clean, dirt-free air.

For small gasoline engines there a variety of air cleaners that are used. These include but are not limited to:

- Dry element air cleaner
- Oil-foam air cleaner
- Oil bath air cleaner

This section should involve demonstrations of how each system could work. As well, practical views of where the system is on the engine and which one is specifically in use on the engines we are using would also be useful.

An analogy of the air cleaner could be the use of masks when in a dusty situation. The individual in question would operate better when wearing a mask than when they take in the dust directly.

Student Activity:

Students should take the opportunity to view the air filter in their car or other small engine-based machinery. They can take some digital photos and share them with the class as a whole.

Topic 3 – Fuel Systems

Suggestions for Assessment

Research/Discussion

- Students research the various types of air cleaners used in gasoline engines and comment in a class discussion why the filters have advanced to paper-based and oil-foam cleaners.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Air Filter - http://en.wikipedia.org/wiki/Air_filter
- Briggs & Stratton resource site - http://thepowerportal.com
- Dry element air cleaner - http://www.tpub.com/content/engine/14081/css/14081_38.htm
- Replacing foam filter - http://www.briggsandstratton.com/maint_repair/routine_maintenance/changing_air_filters/foam.aspx
- Oil bath type - http://www.tpub.com/content/recoveryvehicles/TM-5-4240-501-14P/css/TM-5-4240-501-14P_96.htm
- How to oil a foam filter - http://www.ehow.com/how_5673323_oil-uni_filter-foam-filter.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

NOTES

- Appendix A - Notes section pg. 7

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.7 demonstrate the proper procedure/ tools used in the examination of the fuel system [2.401, 2.404]

Suggested Learning and Teaching Strategies

This section is intended to be done as an practical hands-on activity. Students will need to kinesthetically learn the processes that are involved in each of the following steps of examining a fuel system. Although learning the terms and names and uses of tools was to be done in the previous section, some of this work can be done in concert with this outcome. Students will perform the following procedures to assess the performance of the fuel system. Students must be encouraged to begin with the easiest test to complete and then work up to more complicated procedures.
The procedures are:

- Clean and condition the air cleaner
- Clean and condition the fuel filter(if installed)
- Check and adjust carburetor main fuel adjustment
- Check and adjust carburetor idle fuel adjustment
- Check and adjust idle screw
- Check and adjust governor
- Disassemble/reassemble carburetor

Student Activity:

Students complete the procedures. This can be incorporated into a research assignment where students write out each step and then perform each. A checklist could be developed to confirm that each procedure is completed by the students.

Topic 3 – Fuel Systems

Suggestions for Assessment

Practical Activity

- Students practice the use of tools necessary for the examination of a fuel system. They could demonstrate their capability for the teacher.

Research/Presentation

- Students take one process or series of processes for the examination of a fuel system and outline the proper use and what is to be looked for. This could be presented to the class as a whole or as a poster.

Paper and pencil/Demonstration

- Students be able to demonstrate that they can use these tools safely. This is tied specifically into the first unit of the course. All of these tools need to be qualified for through demonstration and safety quizzes.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Troubleshooting fuel system - http://www.laserfaq.org/sam/lmfaq.htm
- Glossary of engine terms - http://www.briggsandstratton.com/engine_power/engine_glossary.aspx
- Small engine diagnosis - http://www.westongm.eclipse.co.uk/Diagnosis.html
- No start diagnostics - http://hubpages.com/hub/No-Start-Diagnostics-on-a-Small-Engine

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- Carburetor adjustment tool
- Flat top screwdriver
- socket wrench

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.8 complete a breakdown and assembly of a 4 stroke cycle fuel system [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

This outcome is a practical activity. Each student group should be given one engine that will remain designated to them for the rest of the activities. This specific system has hazards that need to be dealt with before completing the process. The fuel system, by role, may contain flammable substances and all safety procedures must be adhered to. Students should drain all fuel system components before working on them, and insure that fuel is not spilled in the tear down process.

Students will explore the fuel system by completing a full tear down of all related components. These steps include but are not limited to:

- identify and remove the air cleaner,
- identify and remove the fuel reservoir,
- remove fuel transfer paraphernalia,
- identify and remove the governor,
- identify and remove carburetor assembly.

In the process of doing this breakdown students also specifically identify:

- fuel type
- primer vs. choke
- carburetor type

Student Activity:

Students should be prepared to reassemble their engine after the completion of this activity, keeping this in mind throughout the tear-down section.

Topic 3 – Fuel Systems

Suggestions for Assessment

Practical Activity

- Students perform a tear down of a small gas engine fuel system. This should be done in a fashion to insure that reassembly will be easily accomplished.

Research/Practical Activity

- Students refer to the manufacturers script on tear-down and develop a proper sequencing for the tear-down of a fuel system

Research/Discussion

- Students research the methods for breakdown of different fuel systems (those not used on the engine in question) and discuss with the remainder of the class the differences in question.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Troubleshooting & repair notes - http://www.zekfrivolous.com/faq/REPAIR/lmfaq.htm
- Cleaning a carburetor - http://www.ehow.com/how_4770374_clean-small-engine-carburetor.html
- Choke valve explained - http://en.wikipedia.org/wiki/Choke_valve
- How primer works - http://www.ehow.com/how-does_5006420_how-small-engine-primer-works.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- Carburetor adjustment tool
- Flat top screwdriver
- socket wrench

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.9 using a variety of troubleshooting techniques identify a fuel system problem on a malfunctioning 4 stroke cycle engine [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

As discussed in an earlier section troubleshooting processes are systematic, and when followed will give students a path to follow to solve problems in almost any situations. This outcome deals specifically with troubleshooting small gas engines fuel systems, and thus will involve steps in the process specific to that.

The fuel system has specific problems associated with it, most of them involve:

- the engine not starting,
- misfiring, or
- loss of power during load.

There may be more than this but these are three that can be attributed to the fuel system. A problem for the whole engine has to be isolated to a single system to tell the individual where to start and which systems to isolate for further study.

When troubleshooting, students should start at the easiest solution to the problem and work their way up to the most complex.

Student Activity:

Students will reference the engine manual to find trouble shooting information. Manufacturers often provide troubleshooting charts to help identify problem situations and suggest a means to rectify each.

Topic 3 – Fuel Systems

Suggestions for Assessment

Practical Activity

- Students undertake a troubleshooting process on a malfunctioning small gas engine. This malfunction should be centred on the fuel system. Students will be expected to identify the problem and the steps they used in the process.

Research/Presentation

- Students refer to the manufacturer's troubleshooting section dealing with fuel systems. A comparison of what the manufacturers guide says to what was actually undertaken could be done at this point. A presentation to the class on the differences or a short discussion could result.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site http://thepowerportal.com
- Troubleshooting & repair notes - http://www.zekfrivolous.com/faq/REPAIR/lmfaq.htm
- Mower won't start - http://www.thisoldhouse.com/toh/skill-builder/0,,1212639,00.html
- Mower trouble 101 - http://www.homeservicesengine.com/articles/tips_mowertrouble.html
- How to service lawn mower - http://www.theworkshop.net/workshoptips/lawnmowertips.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- carburetor adjustment tool
- flat top screwdriver
- socket wrench

Topic 3 – Fuel Systems

Specific Curriculum Outcomes

Students will be expected to

3.3.10 using proper tools and procedures solve a fuel system problem on a malfunctioning 4 stroke cycle engine [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

This outcome is intended to be completed with the previous outcome and after student groups have completed their tear down section. A series of engines, not involved in the tear down section, should be available for this outcome. These engines should be in good working order before this outcome is undertaken. It is suggested that these engines simulate fuel system problems. This is also necessary for the previous outcome. Students could troubleshoot the problem, attempting to identify it from their processes, and then correct it using the proper techniques learned in the previous sections.

Although this troubleshooting section is placed at the end of this topic and other topics to come, it is possible to separate out the troubleshooting of each topic and have it as a stand-alone module. This would allow for students to do troubleshooting without knowledge of which engine system they are dealing with. It would also increase the number of modules in this section.

Students follow the process below, starting from the easiest resolution to the most complex:

- Check fuel supply (gas in the tank)
- Check condition of the air cleaner
- Check condition of gas tank vent
- Check spark plug for presence of gas
- Check for spark on plug
- Check for engine flooding
- Check and adjust idle screw
- Check and adjust main fuel adjustment screw

Topic 3 – Fuel Systems

Suggestions for Assessment

Practical Activity

- Students could, using proper tools and procedures, solve a fuel system problem on a malfunctioning 4 stroke cycle engine.

Research/Discussion

- Students research the most common troubleshooted problems of the 4 stroke cycle engine. They acquire what statistics are available and share these with the class in a discussion with the whole class or in small groups.

Work Log/Portfolio

- Students outline the procedure they used to solve their engine problem.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Troubleshooting & repair notes - http://www.zekfrivolous.com/faq/REPAIR/lmfaq.htm
- Mower won't start - http://www.thisoldhouse.com/toh/skill-builder/0,,1212639,00.html
- Mower trouble 101 -http://www.homeservicesengine.com/articles/tips_mowertrouble.html
- How to service lawn mower - http://www.theworkshop.net/workshoptips/lawnmowertips.html
- Cleaning a carburetor - http://www.ehow.com/how_4770374_clean-small-engine-carburetor.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- Carburetor adjustment tool

Topic 4 – Valve Train/Timing System

Specific Curriculum Outcomes

Students will be expected to

3.4.1 locate appropriate sections of the manufacturer's service manual, dealing with the valve train/timing system on a 4 stroke cycle engine [2.404]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to familiarize and enable to students to use manufacturer's service manuals. All of the information needed to work on a small engine is found in this guide.

Service technicians must have a solid grounding in the reference materials provided by manufactures. Students will explore the valve train/timing system information contained in a sampling of these references. Engine manufacturers use model numbers that encodes engine specifications about the various systems used on a given engine. Students should be able to decode this information.

Students should be able to identify the:

- intake valve
- exhaust valve
- flywheel key (or electronic ignition being present)

from the manual provided. A check that this manual is the proper one for the engine in question should also be undertaken.

Student Activity:

Students study the section in the service manual that relate to the maintenance and repair of the valve train/timing system.

Topic 4 – Valve Train/Timing System

Suggestions for Assessment

Research

- Students research the version of the manual they are using to ensure that it is the most current.

Research Assignment

- Students research manuals from other engine manufacturers and compare how they are laid out, the language used and the diagrams. These commonalities or differences should be itemized in a written assignment.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Engine timing - http://en.wikipedia.org/wiki/Internal_combustion_engine
- Four strokes/timing - http://www.howstuffworks.com/engine1.htm

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 4 – Valve Train/Timing System

Specific Curriculum Outcomes

Students will be expected to

3.4.2 demonstrate knowledge of terms and tools used in the industry for valve train/timing systems of a 4 stroke cycle engine [1.405]

Suggested Learning and Teaching Strategies

This outcome will help students identify the tools necessary to service /repair the valve train/timing system. As well, the use of proper terminology will enable students to be able to identify parts and functions more readily from manufacturers' documentation. It is suggested to cover the terms first and the tools in specific reference to their use and corresponding part of the valve train/timing system. To this end, the terms are listed first below. This list of valve train/timing terms is not all-inclusive but is sufficient for the tasks at hand.

Students will be able to define the following terms:

- head
- stem
- margin
- seat
- face
- cam
- cam shaft
- cam lobe
- crankcase breather
- retaining pins, and
- collars

Students should have a broad-based understanding of these terms, and should review them and use them in class and in practical activities.

Each of the tools listed below has a specific purpose for the valve train/timing systems. Some will have roles in other tear down activities, but for the most part are only used for the purpose their name describes:

- valve spring compressors,
- valve grinders,
- dial caliper,
- feeler gauge,
- pins,
- collars and washers.

Topic 4 – Valve Train/Timing System

Suggestions for Assessment

Research/Paper and pencil

- Students research the origin for some of the terms and tools used in this section. This could be done in a written report or presentation to the class.

Work Log/Portfolio

- Students should start keeping a list of all the terms in each of the sections. These terms should be defined in the work log, accompanied by images or drawings to indicate what the term refers to in the ignition assembly.

- Students start keeping a list of all the tools they come in contact with in each of the sections. These tools could be described in the work log, accompanied by images or drawings to indicate what the tool is for, and how it is used.

Research/Presentation

- Students research the origin and previous versions of the tools they are learning about in this section. They compare the "older" tool type to the new and improved type , attempting to see why the improvement was made. This information could be presented to the class as a whole or as a poster.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Automotive dictionary - http://www.motorera.com/dictionary/ig.htm
- Valve train parts - http://en.wikipedia.org/wiki/Valvetrain
- Valve grinding - http://www.tpub.com/content/construction/14264/css/14264_96.htm
- Using valve spring compressor - http://www.youtube.com/watch?v=c3ZecZW68E8

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 4 – Valve Train/Timing System

Specific Curriculum Outcomes

Students will be expected to

3.4.3 demonstrate the proper procedure/ tools used in the examination of the valve train/timing system [2.401, 2.404]

Suggested Learning and Teaching Strategies

This section is intended to be done as an practical/hands-on activity. Students will need to kinesthetically learn the processes that are involved in each of the following steps of examining a valve train/timing system. Although learning the terms and names and uses of tools was to be done in the previous section, some of this work can be done in concert with this outcome. Students will perform the following procedures to assess the performance of the valve train/timing system. Students must be encouraged to begin with the simplest test and work up to more complicated procedures. This is how the procedures are laid out:

- Determine valve retaining methods
- Observe valve timing in operation
- Access and adjust valve timing by aligning timing marks on cam and crank shafts as necessary
- Examine condition of the valve.

Student Activity:

Students can complete the procedures. This can be incorporated into a research assignment where students write out each step and then perform each. Teacher should develop a checklist to confirm that each procedure is completed by the students.

Topic 4 – Valve Train/Timing System

Suggestions for Assessment

Practical Activity

- Students practice the use of tools necessary for the examination of a valve train/timing system. They should demonstrate their capability for the teacher.

Research/Presentation

- Students take one process or series of processes for the examination of a valve train/timing system and outline the proper use and what is to be looked for. This could be presented to the class as a whole or as a poster.

Paper and pencil/Demonstration

- Students should be able to demonstrate that they can use these tools safely. This is tied specifically into the first unit of the course. All of these tools need to be qualified for through demonstration and safety quizzes.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Using valve spring compressor - http://www.youtube.com/watch?v=c3ZecZW68E8
- Valve lapping - http://www.youtube.com/watch?v=fhXsH12Rg6s&feature=related

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 4 – Valve Train/Timing System

Specific Curriculum Outcomes

Students will be expected to

3.4.4 complete a breakdown and assembly of a 4 stroke cycle valve train/timing system [2.401, 2.404]

Suggested Learning and Teaching Strategies

This outcome is a practical activity. Each student group should be given one engine that will be theirs for the rest of the activities. In this systems case special care has to be taken in removal of certain parts. Use of a valve spring compressor will be necessary, and proper use is important to prevent damage to the engine or any injury in the fabrication room environment.

Students will explore the valve train/timing system by completing a full tear down of all related components. These steps include but are not limited to:

- Remove cylinder head and shield noting sequence of head bolts
- Remove engine sump cover
- Remove centrifugal governor from crank shaft if so equipped
- Remove cam shaft and tappets
- Remove crankcase breather valve and determine valve retaining method employed
- Remove valve springs and valves
- Remove tappets
- Re-assemble engine using proper torque and sequence when re-installing bolts.

Student Activity:

Students should be prepared to reassemble their engine after the completion of this activity, keeping this in mind throughout the tear-down section.

Topic 4 – Valve Train/Timing System

Suggestions for Assessment

Practical Activity

- Students perform a tear down of a small gas engine valve train/timing system. This should be done in a fashion to insure that reassembly will be easily accomplished.

Research/Practical Activity

- Students refer to the manufacturer's script on tear-down and develop a proper sequencing for the tear-down of a valve train/timing system

Research/Discussion

- Students research the methods for breakdown of different valve train/timing systems (those not used on the engine in question) and discuss with the remainder of the class the differences in question.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- How to tear down a valve assembly - http://www.videojug.com/webvideo/how-to-tear-down-a-cylinder-head-valve-train

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- valve spring compression tool
- feeler gauge
- caliper

Topic 4 – Valve Train/Timing System

Specific Curriculum Outcomes

Students will be expected to

3.4.5 measure valve train/timing system components with the appropriate industry measurement tools [2.401, 2.404]

Suggested Learning and Teaching Strategies

Each section of the small engine has to be properly aligned and set up to allow for smooth and proper operation. As students work through tear downs they need to be able to experience what measurements have to be taken and how those measuring devices operate. The best way for this to occur is for students to use these measuring devices when they are doing their tear down. Experiential learning is the most effective method for learning the use of tools and measuring devices in most cases, so covering this outcome with the section on tear down would be appropriate.

Students should be able to identify and use tools to accurately measure valve and timing specifications. For the most part the valve train/timing system has the following measurements to be taken:

- Remove cylinder head and shield.
- Uncover valves by removing things such as exhaust and crankcase breather valve.
- Locate minimum and maximum valve tappet clearance values for intake and exhaust valves for your model and series engine.
- Use feeler gauge to measure minimum and maximum tappett clearances following the proper procedures for doing so as outlined in service manual.
- Use dial caliper and feeler gauge to take accurate tappet clearance measurements.

In most cases the feeler gauge is the tool for the measurements.

Student Activity:

Students expand on this section by doing some research into high performance and how changing some of the measurements listed above will affect performance for the better or the worse.

Topic 4 – Valve Train/Timing System

Suggestions for Assessment

Practical Activity

- Students practice their use of the individual measuring tools used in this section by measuring objects with known measurement values. The results the students obtain could then be compared to a known standard and in this way mastery could be determined.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Automotive Systems - http://www.waybuilder.net/sweethaven/MechTech/Automotive01/default.asp?unNum=1&lesNum=3&modNum=4

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- valve spring compression tool
- feeler gauge
- caliper

Topic 4 – Valve Train/Timing System

Specific Curriculum Outcomes

Students will be expected to

3.4.6 diagnose potential valve train/timing system problems that will reduce engine economy [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

In the previous two sections students were involved in a troubleshooting and resolution activity involving the systems being studies. Within the valve train and timing section simple troubleshooting and repair are complex and involve disassembling most of the engine for access. This section will focus on diagnosing problems specific to this area before starting on resolution.

There are basically only a few things that can go wrong with a valve train/timing system to reduce engine economy. In some cases these would also inhibit proper running or starting. This list includes but is not limited to:

- Engine is off timing
- Stuck valve
- Non-seating valve
- Valve retaining method
- Valve/tappet clearance problem

These problems can be determined to a certain degree through what is occurring within the engine. Within a troubleshooting process, when all the simple and most obvious problems are discarded as being the cause then more complex and involved areas should be examined.

Student Activity:

Students identify the specific symptoms that indicate that the problem originates in the valve train/timing system, and in this way be able to identify such problems from the symptoms.

Topic 4 – Valve Train/Timing System

Suggestions for Assessment

Research/Presentation

- In this and other sections dealing with diagnosing of problems from symptoms, students research the various engine types and what each symptom could mean. This could be developed into a chart that is placed in the lab or as a presentation to the class as a whole.

Work log/Portfolio

- Students put the chart developed previously into their work log along with the symptoms they have identified for this section.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Diagnosing Valve-Timing issues - http://www.aa1car.com/library/ar594.htm
- Timing is everything - http://findarticles.com/p/articles/mi_qa3828/is_199908/ai_n8875172/
- Fault Diagnosis - http://www.westongm.eclipse.co.uk/Diagnosis.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- valve spring compression tool
- feeler gauge
- caliper

Topic 5 – Compression System

Specific Curriculum Outcomes

Students will be expected to

3.5.1 locate appropriate sections of the manufacturer's service manual, dealing with the compression system on a 4 stroke cycle engine [2.404]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to familiarize and enable to students to use manufacturer's service manuals. All of the information needed to work on a small engine is found in this guide. This topic and the previous one are similar. The compression system involves the valve train/timing system, but the valve train/timing system have specific considerations

Service technicians must have a solid grounding in the reference materials provided by manufacturers. Students will explore the compression system information contained in a sampling of these references. Engine manufacturers use model numbers that encodes engine specifications about the various systems used on a given engine. Students should be able to decode this information.

Students should be able to identify the:

- valves
- gaskets
- piston
- rings, and
- crankcase breather compression.

from the manual provided. A check that this manual is the proper one for the engine in question should also be undertaken.

Student Activity:

Students study the section in the service manual that relate to the maintenance and repair of the valve train/timing system.

Topic 5 – Compression System

Suggestions for Assessment

Research

- Students research the version of the manual they are using to ensure that it is the most current.

Research Assignment

- Students research manuals from other engine manufacturers and compare how they are laid out, the language used and the diagrams. These commonalities or differences could be itemized in a written assignment.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Animated Four stroke engine - http://www.animatedengines.com/otto.shtml
- How stuff works - http://auto.howstuffworks.com/engine3.htm
- Comparison between 2 and 4 stroke engine - http://www.deepscience.com/articles/engines.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 5 – Compression System

Specific Curriculum Outcomes

Students will be expected to

3.5.2 demonstrate knowledge of terms and tools used in the industry for compression systems of a 4 stroke cycle engine [1.405]

Suggested Learning and Teaching Strategies

This outcome will help students identify the tools necessary to service /repair the compression system. As well, the use of proper terminology will enable students to be able to identify parts and functions more readily from manufacturers' documentation.

Each of the tools listed below has a specific purpose for the compression system. Some will have roles in other tear down activities, but for the most part are only used for the purpose their name describes:

Students will be able to describe the use of the following tools:

- torque wrench,
- ring compressor,
- ring expander,
- valve lappers,
- valve spring compressor,
- feeler gauge,
- leak down tester, and
- compression tester

Students should not only be able to identify the purpose of the tool in question, but be able to recognize and manipulate the tool to some extent. The use of specific tool demos in this section would be indicated.

Student Activity:

Students do some activities to help them remember the name of each tool and its purpose. Linking the name to the purpose would be most effective and easy in some of the cases.

Topic 5 – Compression System

Suggestions for Assessment

Research/Paper and pencil

- Students research the origin for some of the terms and tools used in this section. This could be done in a written report or presentation to the class.

Work Log/Portfolio

- Students start keeping a list of all the tools they come in contact with in each of the sections. These tools could be described in the work log, accompanied by images or drawings to indicate what the tool is for, and how it is used.

Research/Presentation

- Students research the origin and previous versions of the tools they are learning about in this section. They compare the "older" tool type to the new and improved type , attempting to see why the improvement was made. This information could be presented to the class as a whole or as a poster.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Compression tools - http://www.aa1car.com/library/compression.htm
- List of tools - http://www.mfgsupply.com/SmEngToolsEng.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 5 – Compression System

Specific Curriculum Outcomes

Students will be expected to

3.5.3 measure compression system components with the appropriate industry measurement tools [2.401, 2.404]

Suggested Learning and Teaching Strategies

Each section of the small engine has to be properly aligned and set up to allow for smooth and proper operation. As students work through tear downs they need to be able to experience what measurements have to be taken and how those measuring devices operate. The best way for this to occur is for students to use these measuring devices when they are doing their tear down. Experiential learning is the most effective method for learning the use of tools and measuring devices in most cases, so covering this outcome with the section on tear down would be appropriate.

Students should be able to identify and use tools to accurately measure compression specifications. For the most part the compression system has the following measurements to be taken:

- Perform a compression test and compare results to engine specifications.
- Perform a leak down test and compare to engine specifications.

The tools to be used here are the compression and leak down testers, with each of them used for the specific purpose outlined.

Student Activity:

Students expand on this section by doing some research into high performance and how changing some of the measurements listed above will affect performance for the better or possibly for the worse.

Topic 5 – Compression System

Suggestions for Assessment

Practical Activity

- Students practice their use of the individual measuring tools used in this section by measuring objects with known measurement values. The results are then compared to a known standard and in this way mastery could be determined.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Engine Compression testing - http://www.aa1car.com/library/compression.htm
- How to measure compression - http://www.bukisa.com/articles/244001_how-to-measure-the-engine-compression
- How to measure car engine compression - http://www.automedia.com/engine_compression_test/ccr20050801cc/1

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- ring compressor and expander,
- valve lappers,
- valve spring compressor,
- feeler gauge,
- leak down tester, and
- compression tester

Topic 5 – Compression System

Specific Curriculum Outcomes

Students will be expected to

3.5.4 demonstrate the proper procedure/tools used in the examination of the compression system [2.401, 2.404]

Suggested Learning and Teaching Strategies

This section is intended to be done as an practical/hands-on activity. Students will need to kinesthetically learn the processes that are involved in each of the following steps of examining a compression system. Although learning the terms and names and uses of tools was to be done in the previous section, some of this work can be done in concert with this outcome. Students will perform the following procedures to assess the performance of the compression system. Students must be encouraged to begin with the simplest test and work up to more complicated procedures. This is how the procedures are laid out.

Perform basic measurements on various engine parts using the following tools:

- torque wrench,
- compression tester ,
- leak down tester,
- ring expander,
- ring compressor,
- feeler gauge,
- cylinder hone,
- dial caliper,
- dial bore gauge, and
- telescoping gauge.

Student Activity:

Students can complete the procedures. This can be incorporated into a research assignment where students write out each step and then perform each. Teacher should develop a checklist to confirm that each procedure is completed by the students.

Topic 5 – Compression System

Suggestions for Assessment

Practical Activity

- Students practice the use of tools necessary for the examination of a compression system. They could demonstrate their capability for the teacher.

Research/Presentation

- Students take one process or series of processes for the examination of a compression system and outline the proper use and what is to be looked for. This could be presented to the class as a whole or as a poster.

Paper and pencil/Demonstration

- Students should be able to demonstrate that they can use these tools safely. This is tied specifically into the first unit of the course. All of these tools need to be qualified for through demonstration and written safety quizzes.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- How to check engine compression - http://www.2carpros.com/dia/how_to_check_compression.htm
- Measuring engine compression - http://www.search-autoparts.com/searchautoparts/article/articleDetail.jsp?id=16170

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- ring compressor and expander,
- valve lappers,
- valve spring compressor,
- feeler gauge,
- leak down tester, and
- compression tester

Topic 5 – Compression System

Specific Curriculum Outcomes

Students will be expected to

3.5.6 diagnose potential compression system problems that will reduce engine economy [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

In the first two sections in this unit students were involved in a troubleshooting and resolution activity involving the systems being studies. Within the compression section simple troubleshooting and repair are complex and involve disassembling most of the engine for access. Due to this fact this section will be about diagnosing problems that are specific to this area before starting on resolution.
For the purpose of this outcome the list of processes to be undertaken for diagnosis are:

- Rotate engine through compression stroke manually to feel for major compression loss
- If engine appears to have adequate compression then test for a more accurate reading with compression tester and or leak down tester. Results should be compared.
- Determine source of compression loss if found, (worn / missing gaskets, tappet clearance, missing/worn/broken rings, out of round cylinder, valve seat…)

These problems can be determined to a certain degree through what is occurring within the engine. Within a troubleshooting process, when all the simple and most obvious problems are discarded as being the cause then more complex and involved areas should be examined.

Student Activity:

Students identify the specific symptoms that indicate that the problem originates in the compression system, and in this way be able to identify such problems from the symptoms.

Topic 5 – Compression System

Suggestions for Assessment

Research/Presentation

- In this and other sections dealing with diagnosing of problems from symptoms, students research the various engine types and what each symptom could mean. This could be developed into a chart that is placed in the lab or as a presentation to the class as a whole.

Work log/Portfolio

- Students put the chart developed previously into their work log along with the symptoms they have identified for this section.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- No start troubleshooting guide - http://www.samarins.com/diagnose/index.html
- Engine problems - http://auto.howstuffworks.com/engine3.htm
- Engine compression test - http://www.youfixcars.com/engine-compression-test.html
- Diagnosing car problems - http://www.ehow.com/articles_2283-diagnosing-car-problems.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- ring compressor and expander,
- valve lappers,
- valve spring compressor,
- feeler gauge,
- leak down tester, and
- compression tester

Topic 6 – Lubrication/Cooling System

Specific Curriculum Outcomes

Students will be expected to

3.6.1 locate appropriate sections of the manufacturer's service manual, dealing with the lubrication/cooling system on a 4 stroke cycle engine [2.404]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to familiarize and enable to students to use manufacturer's service manuals. All of the information needed to work on a small engine is found in this guide.

Service technicians must have a solid grounding in the reference materials provided by manufacturers. Students will explore the lubrication/cooling system information contained in a sampling of these references. Engine manufacturers use model numbers that encodes engine specifications about the various systems used on a given engine. Students should be able to decode this information.

Students should be able to:

- Remove sump cover
- Determine which type of lubrication system your engine uses (i.e., slinger, dipper, splash, pump.)

from the manual provided. A check that this manual is the proper one for the engine in question should also be undertaken.

Student Activity:

Students study the section in the service manual that relate to the maintenance and repair of the lubrication/cooling system. Included in this is the determination of whether the engine is air-cooled or liquid cooled.

Topic 6 – Lubrication/Cooling System

Suggestions for Assessment

Research

- Students research the version of the manual they are using to ensure that it is the most current.

Research Assignment

- Students research other manuals from other engine manufacturers and compare how they are laid out, the language used and the diagrams. These commonalities or differences could be itemized in an assignment.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 6 – Lubrication/Cooling System

Specific Curriculum Outcomes

Students will be expected to

3.6.2 demonstrate knowledge of terms and tools used in the industry for lubrication/cooling systems of a 4 stroke cycle engine [1.405]

Suggested Learning and Teaching Strategies

This outcome will help students identify the tools necessary to service /repair the lubrication/cooling systems. As well, the use of proper terminology will enable students to be able to identify parts and functions more readily from manufacturers' documentation. It is suggested to cover the terms first and the tools in specific reference to their use and corresponding part of the lubrication/cooling system. To this end, the terms are listed first below. This list of lubrication/cooling system terms is not all-inclusive but is sufficient for the tasks at hand.
Students will be able to define the following terms:

- Abrasion
- Adhesion
- Additives
- Base
- Corrosion protection
- Cohesion
- Coolant
- Corrosion
- Density
- Deposits
- Friction
- Graphite
- Viscosity

Students should have a broad-based understanding of these terms, and should review them and use them in class and in practical activities.

Topic 6 – Lubrication/Cooling System

Suggestions for Assessment

Research/Paper and pencil

- Students research the basis for some of the terms and tools used in this section. This could be done in a written report or presentation to the class.

Work Log/Portfolio

- Students should start keeping a list of all the terms in each of the sections. These terms should be defined in the work log, accompanied by images or drawings to indicate what the term refers to in the ignition assembly.

- Students should start keeping a list of all the tools they come in contact with in each of the sections. These tools should be described in the work log, accompanied by images or drawings to indicate what the tool does, and how it is used.

Research/Presentation

- Students research the origin and previous versions of the tools they are learning about in this section. They could compare the “older” tool type to the new and improved type , attempting to see why the improvement was made. This information could be presented to the class as a whole or as a poster.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Terms for cooling systems - http://mypage.direct.ca/k/kdomries/cooling.html
- Cooling systems - http://www.grc.nasa.gov/WWW/K-12/airplane/cooling.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 6 – Lubrication/Cooling System

Specific Curriculum Outcomes

Students will be expected to

3.6.3 differentiate between the types of lubrication systems found on small gas engines [2.404, 3.401]

Suggested Learning and Teaching Strategies

Lubrication is about insuring that there is less friction in the engine than would normally be produced through its operation. The lubrication is normally an oil-based product which is used for its "slipperiness". There are two methods used in the lubrication of a small engine:

- Splash lubrication – slinger/dipper
- Pressure system – pump

A splash lubrication system, as the name would suggest, splashes oil up from the oil pan or oil trays in the lower part of the crankcase. Dippers on the connecting-rod bearing caps dip down into the oil pan with each crankshaft revolution to throw oil upward as drops to provide adequate lubrication to the engine mechanism.

The pressure or pump system does not rely as heavily on the mechanism of the parts to be lubricated for operation but rather on a pump system. The oil in the oil reservoir is distributed through the parts requiring lubrication by pumping it under pressure.

Student Activity:

Students attempt to find out what sort of lubrication system is in use in the various engine-based devices they use at home. This is a good place to emphasize the difference between a two-stroke and a four-stroke engine, as lubrication in the two-stroke is undertaken by mixing the gas and oil.

Topic 6 – Lubrication/Cooling System

Suggestions for Assessment

Research/Presentation

- Students research other methods of lubrication used in different engine types. In this research they could also look at the methods used in history. A short presentation to the class on this material could be accomplished.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Types of lubrication systems - http://www.tpub.com/content/construction/14264/css/14264_242.htm
- How stuff works - http://auto.howstuffworks.com/engine6.htm

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

NOTES

- Appendix A - Notes section pg. 8

Topic 6 – Lubrication/Cooling System

Specific Curriculum Outcomes

Students will be expected to

3.6.4 describe characteristics of various lubrications used in small gas engines [2.404, 3.401]

Suggested Learning and Teaching Strategies

This outcome deals with making students familiar with the vagaries of lubrication. Methodology of dispersing lubricants is one issue but the various types, grades and other scientific properties are important. The common differences between engine lubricants can be summarized by:

- Types of lubricant – mineral, blended or synthetic
- Engine oil weights...viscosity (eg. 10W-30)
- Oil additives

Most if not all of the properties of oil discussed above are voluntarily regulated by American Petroleum Institute (API). This is usually found in a circular seal on the outside of the oil container, nicknamed the donut.

Mineral oil is oil that is distilled in some manner from crude oil. Synthetic oil contains compounds that do not occur naturally in crude oil and blended oils are usually about 30% synthetic and the rest mineral.

Oil weight, or viscosity, refers to how thick or thin the oil is. They are usually measured at high temperatures, around 100 ^{O}C and at low temperatures, around 0 ^{O}C. The numbers have special meaning and refer to the viscosity at low temp (the first number) and at high temp (the second number). So 10W-30 oil has a cold temp viscosity of 10 and high temp viscosity of 30. Theses are commonly called all season or all-weather oils.

All other information on the oil including performance levels, viscosity, and whether an oil is energy conserving is found within the API Donut on the outside of the oil container.

Topic 6 – Lubrication/Cooling System

Suggestions for Assessment

Research/Portfolio/Work Log

- Students research the concept of viscosity and define it for their work log/portfolio. When researching it they could include why viscosity changes at different temperatures.

Research/Presentation/Discussion

- Students research different types of engine oils and how they benefit engine economy or performance and why. Each student group could be given one type of oil to prepare a report on for the whole class.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Types of lubrication - http://www.performanceoiltechnology.com/types_of_lubrication.htm
- Types of lubricant - http://www.alternative-energy-resources.net/types_of_lubricants.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 6 – Lubrication/Cooling System

Specific Curriculum Outcomes

Students will be expected to

3.6.5 compare and contrast the types of cooling systems found on small gas engines [2.404, 3.401]

Suggested Learning and Teaching Strategies

All internal combustion engines produce heat as function of their operation. In most cases it is the conversion of this heat in one way or another into mechanical energy that is the cornerstone of operation within an engine. They produce much more heat than they are able to convert into mechanical energy and this “waste” heat must have a place to go. In some instances the excess heat is not dissipated properly and engines “overheat”. This can cause warping of heads, damage to cylinders and general failure of various engine parts, hence it is something to be avoided. Most of an engine’s heat is released through the exhaust, but if even one part fails due to heat then the whole engines fails. Some is absorbed by the lubricant, hence the reason that oil weights are expressed at different temperatures. As a supplementary method of removing heat from engines one of the two following processes is employed:

- air cooling, or
- liquid cooling.

Air cooling involves using the air around the cylinders to cool off the engine. The cylinders are surrounded by fins that increase the surface area that can be contacted by the air and help dissipate the heat to the air.

Liquid cooling involves running an amount of liquid around the engine parts and then through a heat exchanger that cools the liquid down by using the air around it. This heat exchanger is commonly called a radiator. In marine engines, water is constantly piped in and out of the cooling system and doesn’t require air to cool it , while in common land applications the water is in a closed system and moves around the engine components where it picks up heat and then to the radiator where it dissipates it.

Student Activity:

Students identify the cooling method on common engines at their home.

Topic 6 – Lubrication/Cooling System

Suggestions for Assessment

Research/Work Log/Portfolio

- Students research the various methods of cooling used in a variety of engine types. They could then record these methods in their portfolio.

Research/Presentation/Assignment

- Students create a poster outlining the liquid and air cooled versions of different engines. This could involve a labeled diagram that could be placed on the wall of the fabrication lab or a smaller image that could be included with their portfolio.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- How cooling systems work - http://www.howstuffworks.com/cooling-system.htm
- Automotive cooling systems - http://www.familycar.com/classroom/coolingsystem.htm
- Cooling system - http://mypage.direct.ca/k/kdomries/cooling.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 6 – Lubrication/Cooling System

Specific Curriculum Outcomes

Students will be expected to

3.6.6 measure lubrication/cooling system components with the appropriate industry measurement tools [2.401, 2.404]

Suggested Learning and Teaching Strategies

Each section of the small engine has to be properly aligned and set up to allow for smooth and proper operation. As students work through tear downs they need to be able to experience what measurements have to be taken and how those measuring devices operate. The best way for this to occur is for students to use these measuring devices when they are doing their tear down. Experiential learning is the most effective method for learning the use of tools and measuring devices in most cases, so covering this outcome with the section on tear down would be appropriate.

Students should be able to identify and use tools to accurately measure lubrication/cooling system specifications. For the most part the lubrication/cooling system has the following measurements to be taken:

- Measure oil level, including identification of the dip stick.
- Measure wear on oil scraper ring and oil control ring.

In one instance the measurement takes place with a device that is contained within the engine. In the other a micrometer or vernier caliper would be sufficient.

Student Activity:

Students expand on this section by doing some research into high performance and how changing some of the measurements listed above will affect performance for the better or possibly for the worse.

Topic 6 – Lubrication/Cooling System

Suggestions for Assessment

Practical Activity

- Students practice their use of the individual measuring tools used in this section by measuring objects with known measurement values. The results could then be compared to a known standard and in this way mastery could be determined.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300

Topic 6 – Lubrication/Cooling System

Specific Curriculum Outcomes

Students will be expected to

3.6.7 demonstrate the proper procedure/tools used in the examination of the lubrication/cooling system [2.401, 2.404]

Suggested Learning and Teaching Strategies

This section is intended to be done as an practical/hands-on activity. Students will need to kinesthetically learn the processes that are involved in each of the following steps of examining a lubrication/cooling system. Although learning the terms and names and uses of tools was to be done in a previous section, some of this work can be done in concert with this outcome. Students will perform the following procedures to assess the performance of the lubrication/cooling system. Students must be encouraged to begin with the easiest test to complete and then work up to more complicated procedures. This is how the procedures are laid out.

Perform the basic measurements listed below using appropriate:

- Clean cooling fins on air cooled engines
- Check the condition of engine oil
- Replace engine oil
- Determine the type of lubrication system
- Inspect installation of piston rings for correct order
- Check crankcase breather valve is maintaining partial vacuum. Examine fiber disc and observe if it is binding or moves freely.
- Check manual specs. And ensure vent holes are open correct diameter. (use a wire spark plug gauge)
- Disassemble oil slinger (if equipped) and ensure it is working freely then re-assemble
- If engine is equipped with an oil guard (low oil shut off) then determines which type it is (float or spark gap type) by removing the sump cover or referring to manual.
- Confirm proper operation of float

Student Activity:

Students complete the procedures by incorporating it into a research assignment where students write out each step and then perform each. A checklist could be created to confirm that each procedure is completed by the students.

Topic 6 – Lubrication/Cooling System

Suggestions for Assessment

Practical Activity

- Students practice the use of tools necessary for the examination of a lubrication/cooling system. They should demonstrate their capability for the teacher.

Research/Presentation

- Students take one process or series of processes for the examination of a lubrication/cooling system and outline the proper use and what is to be looked for. This could be presented to the class as a whole or as a poster.

Paper and pencil/Demonstration

- Students should be able to demonstrate that they can use these tools safely. This is tied specifically into the first unit of the course. All of these tools need to be qualified for through demonstration and written safety quizzes.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Flushing a coolant system - http://www.ehow.com/video_2328123_tools-flushing-coolant-system.html
- Diagnostic Tools - http://www.donaldson.com/en/engine/support/datalibrary/000374.pdf

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300

Topic 6 – Lubrication/Cooling System

Specific Curriculum Outcomes

Students will be expected to

3.6.8 complete a breakdown and assembly of a 4 stroke cycle lubrication/cooling system [2.401, 2.404]

Suggested Learning and Teaching Strategies

This outcome is a practical activity. Each student group should be given one engine that will they will use for the rest of the activities. In this systems case special care has to be taken in removal of certain parts. Lubricant can spill if special care is not taken, and avoidance of such spills is the responsibility of the student.

Students will explore the lubrication/cooling system by completing a full tear down of all related components. These steps include but are not limited to:

- Drain sump of oil
- Remove cylinder head
- Remove piston, examine rings
- Remove sump, disassemble slinger
- Pull flywheel in necessary and inspect flywheel key
- Locate and remove crankcase breather valve
- Reinstall piston and rings
- Replace cylinder head gasket if needed
- Reinstall head using proper torque and bolt sequence
- Reinstall crankcase breather
- Reinstall flywheel (key and torque)
- Reinstall slinger if equipped
- Reinstall sump and torque bolts
- Refill sump with fresh oil

In the lubrication section, the oil refilling should take place with oil that is readily available, but students have to undertake this section in a controlled area of the fabrication lab.

Student Activity:

Students should be prepared to reassemble their engine after the completion of this activity, keeping this in mind throughout the tear-down section.

Topic 6 – Lubrication/Cooling System

Suggestions for Assessment

Practical Activity

- Students perform a tear down of a small gas engine lubrication/cooling system. This should be done in a fashion to insure that reassembly will be easily accomplished.

Research/Practical Activity

- Students refer to the manufacturers script on tear-down and develop a proper sequencing for the tear-down of a lubrication/cooling system.

Research/Discussion

- Students research the methods for breakdown of different lubrication/cooling systems (those not used on the engine in question) and discuss with the remainder of the class the differences in question.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Video on engine teardown - http://www.youtube.com/watch?v=uHOoB6o4tHw
- Briggs teardown - http://www.small-engine-repairs.com/briggs_stratton_engine_teardown.html
- Briggs manual download - http://pdfcast.org/pdf/briggs-stratton-small-gas-engine-service-maintenance

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300

Topic 6 – Lubrication/Cooling System

Specific Curriculum Outcomes

Students will be expected to

3.6.9 diagnose potential lubrication/cooling system problems that will reduce engine economy [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

In the previous two sections students were involved in a troubleshooting and resolution activity involving the systems being studies. Within the lubrication cooling section simple troubleshooting and repair are complex and involve disassembling most of the engine for access. This section will focus on diagnosing problems specific to this area before starting on resolution.

There are basically only a few things that can go wrong with a lubrication/cooling system to reduce engine economy.

In some cases these would also inhibit proper running or starting. Students could troubleshoot oil guard system:

- Create a problem / cause / cure chart for the two systems. For example
  - Problem: No Spark
  - Possible cause: Low Oil in Crank, Excessive angle of operation, Defective Sensor,
  - Possible cure: Refill with oil, Reduce angle of operation, Replace sensor
- Create a problem / cause / cure troubleshooting chart as it relates to the lubrication system. For example:
  - Problem: Engine runs hot.
  - Possible cause, low oil level, oil slinger malfunction, oil control ring worn.
  - Possible cure: add oil, replace rings, replace crankcase breather valve

These problems can be determined to a certain degree through what is occurring within the engine. Within a troubleshooting process, when all the simple and most obvious problems are discarded as being the cause then more complex and involved areas should be examined.

Student Activity:

Students identify the specific symptoms that indicate that the problem originates in the valve train/timing system, and in this way be able to identify such problems from the symptoms.

Topic 6 – Lubrication/Cooling System

Suggestions for Assessment

Research/Presentation

- Students research the various engine types and what each symptom could mean. This could be developed into a chart that is placed in the lab or as a presentation to the class.

Work log/Portfolio

- Students enter the chart developed previously along with the symptoms they have identified for this section.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Troubleshooting small engines - http://www.small-engine-repairs.com/
- Notes on troubleshooting - http://www.repairfaq.org/samnew/lmfaq.htm
- Tecumseh small engine checklist - http://www.tecumsehpower.com/CustomerService/BSI.pdf
- Power equipment troubleshooting - http://www.grounds-mag.com/mag/grounds_maintenance_troubleshoot_power_equipment/

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300

Topic 7 – Mechanical System

Specific Curriculum Outcomes

Students will be expected to

3.7.1 locate appropriate sections of the manufacturer's service manual, dealing with the mechanical system on a 4 stroke cycle engine [2.404]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to familiarize and enable to students to use manufacturer's service manuals. All of the information needed to work on a small engine is found in this guide.

Service technicians must have a solid grounding in the reference materials provided by manufactures. Students will explore the mechanical system information contained in a sampling of these references. Engine manufacturers use model numbers that encodes engine specifications about the various systems used on a given engine. Students should be able to decode this information.

Students should be able to recognize the part of the engine that encompass the mechanical system and how they interrelate to provide for proper engine operation. All of this information should be available from the manual provided. A check that this manual is the proper one for the engine in question should also be undertaken.

Student Activity:
Students study the section in the service manual that relate to the maintenance and repair of the mechanical system.

Topic 7 – Mechanical System

Suggestions for Assessment

Research

- Students research the version of the manual they are using to ensure that it is the most current.

Research Assignment

- Students research other manuals from other engine manufacturers and compare how they are laid out, the language used and the diagrams. These commonalities or differences are itemized in an assignment.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Overview of mechanical system - http://www.gov.ns.ca/agri/4h/manuals/smallengines/mech.pdf
- Definition - http://www.thefreedictionary.com/mechanical+system
- Description of a mechanical system - http://machinedesign.com/BDE/mechanical/bdemech5/bdemech5_1.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 7 – Mechanical System

Specific Curriculum Outcomes

Students will be expected to

3.7.2 demonstrate knowledge of terms and tools used in the industry for mechanical systems of a 4 stroke cycle engine [1.405]

Suggested Learning and Teaching Strategies

This outcome helps students identify the tools necessary to service /repair the mechanical system. As well, the use of proper terminology will enable students to identify parts and functions more readily from manufacturers' documentation. It is suggested to cover the terms first and the tools in specific reference to their use and corresponding part of the mechanical system. To this end, the terms are listed first below. This list of mechanical terms is not all-inclusive but is sufficient for the tasks at hand.

- Engine overhaul
- Engine block
- Base pan
- Cylinder head
- Cylinder head gasket
- Crankshaft
- Camshaft
- Piston
- Piston rings (oil control)
- Piston ring (compression)
- Connecting rod
- Connecting rod cap
- Valve lifters
- Valve springs
- Valve keepers
- Governor
- Bearing plate

Students should have a broad-based understanding of these terms, and should review them and use them in class an in practical activities.

Topic 7 – Mechanical System

Suggestions for Assessment

Research/Paper and pencil

- Students research the origin for some of the terms and tools used in this section. This could be done in a written report or presentation to the class.

Work Log/Portfolio

- Students start keeping a list of all the terms in each of the sections. These terms can be defined in the work log, accompanied by images or drawings to indicate what the term refers to in the ignition assembly.

- Students start keeping a list of all the tools they come in contact with in each of the sections. These tools can be described in the work log, accompanied by images or drawings to indicate what the tool does, and how it is used.

Research/Presentation

- Students research the origin and previous versions of the tools they are learning about in this section. They compare the "older" tool type to the new and improved type , attempting to see why the improvement was made. This information could be presented to the class as a whole or as a poster.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Overview of mechanical system - http://www.gov.ns.ca/agri/4h/manuals/smallengines/mech.pdf
- Definition - http://www.thefreedictionary.com/mechanical+system
- Description of a mechanical system - http://machinedesign.com/BDE/mechanical/bdemech5/bdemech5_1.html

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 7 – Mechanical System

Specific Curriculum Outcomes

Students will be expected to

3.7.2 demonstrate knowledge of terms and tools used in the industry for mechanical systems of a 4 stroke cycle engine [1.405]

(cont'd)

Suggested Learning and Teaching Strategies

Each of the tools listed below has a specific purpose for the mechanical system. Some will have roles in other tear down activities, but for the most part are only used for the purpose their name describes.

Tools

- Socket wrench
- Socket wrench driver
- Box end wrench
- Open end wrench
- Torque wrench
- Flywheel puller
- Flywheel holder
- Starter clutch wrench
- Valve spring compressor

Students should not only be able to identify the purpose of the tool in question, but be able to recognize and manipulate the tool to some extent. The use of specific tool demos in this section would be indicated.

Student Activity:

Students do some activities to help them remember the name of each tool and its purpose. Linking the name to the purpose would be most effective and easy in some of the cases.

Topic 7 – Mechanical System

Suggestions for Assessment

Research/Presentation/Paper and pencil

- Students create a tool chart or a series of tool posters with an image of the tool, its proper name and its use in the tear down of a small engine. It could be done in groups with the posters displayed around the room, or as a chart containing all the tools done by each group.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

Topic 7 – Mechanical System

Specific Curriculum Outcomes

Students will be expected to

3.7.3 measure mechanical system components with the appropriate industry measurement tools [2.401, 2.404]

Suggested Learning and Teaching Strategies

Each section of the small engine has to be properly aligned and set up to allow for smooth and proper operation. As students work through tear downs they need to be able to experience what measurements have to be taken and how those measuring devices operate. The best way for this to occur is for students to use these measuring devices when they are doing their tear down. Experiential learning is the most effective method for learning the use of tools and measuring devices in most cases, so covering this outcome with the section on tear down would be appropriate.

Students should be able to identify and use tools to accurately measure mechanical specifications. For the most part the mechanical system has the following measurements to be taken:

- measure cylinder bore,
- measure stroke (distance piston moves top to bottom),
- check engine block head for trueness (use straightedge and feeler gauge to check head flatness)
- repeat above procedure for cylinder head.

In most cases a micrometer or caliper will be the measuring tool of choice but the dial bore gauge also has application at this point.

Student Activity:

Students expand on this section by doing some research into high performance and how changing some of the measurements listed above will affect performance for the better or the worse.

Topic 7 – Mechanical System

Suggestions for Assessment

Practical Activity

- Students practice their use of the individual measuring tools used in this section by measuring objects with known measurement values. The results are then compared to a known standard and in this way mastery could be determined.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com
- Repair small engines - http://home.howstuffworks.com/home-improvement/repair/how-to-repair-small-engines2.htm

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- various wrenches
- torque wrench
- flywheel puller
- flywheel holder
- starter clutch wrench
- valve spring compressor

Topic 7 – Mechanical System

Specific Curriculum Outcomes

Students will be expected to

3.7.4 demonstrate the proper procedure/tools used in the examination of the mechanical system pertaining to repair and maintenance [2.401, 2.404]

Suggested Learning and Teaching Strategies

This section is intended to be done as an practical/hands-on activity. Students will need to kinesthetically learn the processes that are involved in each of the following steps of examining an ignition system. Although learning the terms and names and uses of tools was to be done in the previous section, some of this work can be done in concert with this outcome. Students will perform the following procedures to assess the performance of the mechanical system. Students must be encouraged to begin with the simplest test and work up to more complicated procedures. This is how the procedures are laid out.

Proper disassembly procedure - in the case of the mechanical system most of the measurements in question cannot be taken until after the disassembly of the engine as a whole.

- Check condition of cylinder head for carbon deposits and deformation (surface plate)
- Check condition of crankshaft
- Check condition of cam and crankshaft gears
- Check condition of camshaft
- Inspect engine body for mechanical damage
- Locate timing marks on cam and crankshaft

Student Activity:

Students complete the procedures. This can be incorporated into a research assignment where students write out each step and then perform each. Teacher should develop a checklist to confirm that each procedure is completed by the students.

Topic 7 – Mechanical System

Suggestions for Assessment

Practical Activity

- Students practice the use of tools necessary for the examination of a mechanical system during the tear down procedure. They will demonstrate their capability for the teacher.

Research/Presentation

- Students take one process or series of processes for the examination of a mechanical system and outline the proper use and what is to be looked for. This is presented to the class or completed as a poster.

Paper and pencil/Demonstration

- Students should be able to demonstrate that they can use these tools safely. This is tied specifically into the first unit of the course. All of these tools need to be qualified for through demonstration and written safety quizzes.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- Various wrenches
- Torque wrench
- Flywheel puller
- Flywheel holder
- Starter clutch wrench
- Valve spring compressor

Topic 7 – Mechanical System

Specific Curriculum Outcomes

Students will be expected to

3.7.5 complete a breakdown and assembly of a 4 stroke cycle mechanical system [2.401, 2.404]

Suggested Learning and Teaching Strategies

This outcome is a practical activity. Each student group should be given one engine that will be theirs for the rest of the activities.
Students will be able to disassemble and reassemble a four stroke cycle gasoline.

Procedure:

- Engine disassembly
  - Remove gasoline from gas tank
  - Remove engine oil from engine base
  - Remove engine blower housing
  - Remove gas tank from engine block
  - Remove air vane governor
  - Remove ignition coil/armature
  - Remove flywheel
  - Remove flywheel key
  - Remove cylinder head and gasket
  - Remove bearing plate
  - Remove camshaft
  - Remove valve lifters
  - Remove oil slinger
  - Remove connecting rod cap big end
  - Remove piston
  - Remove intake/exhaust valves(optional)
- Engine reassembly
- Repeat above procedure in reverse

Student Activity:

Students should be prepared to reassemble their engine after the completion of this activity, keeping this in mind throughout the tear-down section.

Topic 7 – Mechanical System

Suggestions for Assessment

Practical Activity

- Students perform a tear down of a small gas engine. This should be done in a fashion to ensure that reassembly will be easily accomplished. To study the mechanical system a full tear down will be necessary.

Research/Practical Activity

- Students refer to the manufacturer's script on tear-down and develop a proper sequencing for the tear-down of a small gas engine.

Research/Discussion

- Students research the methods for breakdown of different mechanical systems (those not used on the engine in question) and discuss with the remainder of the class the differences in question.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- various wrenches
- torque wrench
- flywheel puller
- flywheel holder
- starter clutch wrench
- valve spring compressor

Topic 7 – Mechanical System

Specific Curriculum Outcomes

Students will be expected to

3.7.6 diagnose potential mechanical system problems that will reduce engine economy [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

In the previous sections students were involved in a tear down and examination activity involving the systems being studies. Within the mechanical section simple troubleshooting and repair are complex and involve disassembling most of the engine for access. This section will focus on diagnosing problems specific to this area before starting on resolution.

There are basically only a few things that can go wrong with the mechanical system to reduce engine economy. In some cases these would also inhibit proper running or starting. Students could refer to the troubleshooting chart in the text (appendix), to identify potential mechanical problems. Students must be encouraged to start with simple diagnostics and work to the more potentially complex issues. For example a knocking sound that develops quickly could be an indication of a damaged internal engine component such as damaged connecting rod or even a small piece of carbon.

These problems can be determined to a certain degree through what is occurring within the engine. Within a troubleshooting process, when all the simple and most obvious problems are discarded as being the cause then more complex and involved areas should be examined.

Student Activity:

Students identify the specific symptoms that indicate that the problem originates in the mechanical system, and in this way be able to identify such problems from the symptoms.

Topic 7 – Mechanical System

Suggestions for Assessment

Research/Presentation

- In this and other sections dealing with diagnosing of problems from symptoms, students research the various engine types and what each symptom could mean. This could be developed into a chart that is placed in the lab or as a presentation to the class as a whole.

Work log/Portfolio

- Students enter the chart developed previously along with the symptoms they identified for this section.

Resources

TEXT

- Small Engines, Third Edition, R. Bruce Radcliff
- Small Engines Workbook

WEB

- Briggs & Stratton resource site - http://thepowerportal.com

MATERIALS

- Service manual for specific engine
- Briggs & Stratton tear down scripts provided in course materials.
- Briggs & Stratton power points provided with course materials.

TOOLS

- Briggs and Stratton tool set 19300
- various wrenches
- torque wrench
- flywheel puller
- flywheel holder
- starter clutch wrench
- valve spring compressor

Unit 4: Alternative Energy

Unit 4 Overview

The purpose of this unit is to provide students with an introduction to the concepts and theory of alternative energy. They will learn about the underlying theory and science that supports these technologies. They will see the application of the various theories and how they were harnessed to create a clean energy solution.

Looking at the background of these technologies also shows that what is occurring is an extension of older processes. In each case most of these technologies are more an improvement than they are a new and radical way of doing things. Students should be made aware of this fact, and introduced to the concepts as known quantities so that this material does not seem new or foreign to them, but rather intuitive.

Most of the work involved in the following unit will involve electrical work. The electrician trade of the future will have a significant portion involved in the installation, maintenance and design of alternative energy systems for seasonal and year round accommodations.

Organization

The following unit topics will provide these experiences:

- Topic 1: Types of energy (3 hours)
- Topic 2: Sources of energy (4 hours)
- Topic 3: Power and Energy overview (4 hours)

Assessment

This section constitutes approximately 10% of the course time and the value attributed to it should reflect that status.

Topic 1 – Types of Energy

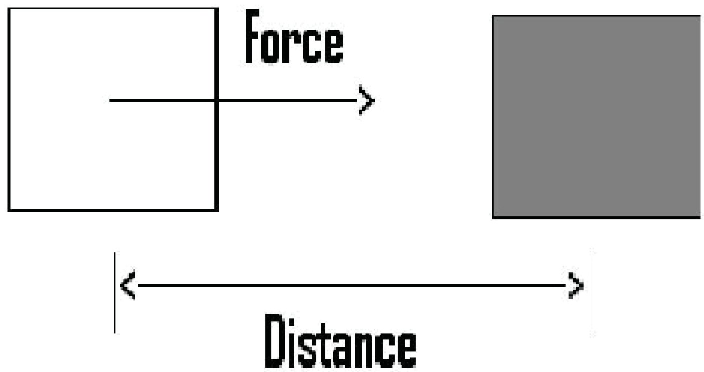
Specific Curriculum Outcomes

Students will be expected to

4.1.1 Understand the relationship between work and energy. [3.402, 3.403]

Suggested Learning and Teaching Strategies

Most of this section is theoretical in nature, but this material forms the basis of how energy is converted and transferred and is important within the study of alternative energy concepts.



Energy is defined as the ability to do work. It doesn't mean that the object will actually move but that it can. This is the only difference between work and energy; they even have the same units of measurement: joules. But we classify energy into two types, and when you start looking at those types you get a better sense of how work and energy are related.

The mathematics of this concept can also be introduced at this point, if it will aid learning and will not confuse students. Qualitative discussions of the concepts are sufficient to meet the outcome.

Topic 1 – Types of Energy

Suggestions for Assessment

Research/Presentation

- Students research the relationship between force and energy, and make a presentation of the various ways this link is used in society

Brainstorming/Discussion

- Students discuss the work energy theory in small groups and brainstorm the uses of it. This includes having each group explain the theory in their own words and how it works.

Research/Assignment

- Students research the theory and discover how it is applied in technology generally and in energy production in particular. This could be passed in as an assignment or added to a course portfolio.

Resources

WEB

- CDLI –
  - http://www.cdli.ca/courses/ep/predesign/t03.htm
  - http://www.cdli.ca/courses/ep/predesign/t03/02knowledge-skills/act-06a.htm
  - http://www.cdli.ca/courses/ep/predesign/t03/02knowledge-skills/act-07a.htm

NOTES

- Appendix A - Notes section pg. 9

Topic 1 – Types of Energy

Specific Curriculum Outcomes

Students will be expected to

4.1.2 differentiate between kinetic and potential energy [3.402, 3.403]

Suggested Learning and Teaching Strategies

The main types of energy for this outcome are:

- Kinetic Energy
- Potential Energy

The connection between work and energy should be emphasized. An example of this is when we lift something off the ground. We exert a force on something to raise it above the ground, and how far we raise it would be the distance we exert that force. The work done to raise that object would then be equal to the potential energy it has gained.

For kinetic energy the force required to stop the motion over the distance it is exerted is the same as the kinetic energy the object has. This would also be the work done to stop the object and would be equal to the kinetic energy.

Mathematically these two theories are represented by:

$E_K = \frac{1}{2}mv^2$ kinetic

$E_p = mgh$ potential

Student Activity:
Students, in small groups or as the whole class, discuss a variety of examples of examples of kinetic energy and potential energy.

Topic 1 – Types of Energy

Suggestions for Assessment

Research/Presentation

- Students research the history of these concepts and present to the class on how long these theories have been in place and how they were developed.

Paper and pencil

- Students explain in their own words the two theoretical concepts of potential and kinetic energy. This should be done in such a way so that students in grade 6 could understand it.

Research/Discussion

- Students classify the various energy uses they know about as being either kinetic or potential energy.

Resources

WEB

- CDLI
  - http://www.cdli.ca/courses/ep/predesign/t03.htm
  - http://www.cdli.ca/courses/ep/predesign/t03/02knowledge-skills/act-06a.htm
  - http://www.cdli.ca/courses/ep/predesign/t03/02knowledge-skills/act-07a.htm
- Forms of Energy - www.need.org/needpdf/FormsofEnergy.pdf

NOTES

- Appendix A - Notes section pg. 9

Topic 1 – Types of Energy

Specific Curriculum Outcomes

Students will be expected to

4.1.3 classify the main types of energy as being either potential or kinetic [3.402, 3.403]

Suggested Learning and Teaching Strategies

The main types of energy can be further broken down into the following sub-types. Each of these has a definite relation to potential and kinetic energy.

- Radiant Energy (kinetic)
- Stored Mechanical Energy (potential)
- Nuclear Energy (potential)
- Motion (kinetic)
- Sound (kinetic)
- Gravitational Energy (potential)
- Thermal (kinetic)
- Electrical Energy (kinetic)
- Chemical (potential)

The knowledge of the different types of energy will also be important when student start studying the types of energy used in alternative energy production. Looking at natural energy sources from their base types of energy will allow a clearer picture of how it can be used.

Student Activity:
Students identify things around them that can be classified as one of the types of energy listed above. Practical examples of each one will aid in learning.

Topic 1 – Types of Energy

Suggestions for Assessment

Research/Assignment

- Students classify all the different sub-types of energy into kinetic or potential energy. An explanation of why they have been placed in each of the two categories should accompany. This can be done in an assignment or in a class discussion.

Research/Presentation

- Students do an internet search of the major types of energy, with specific interest in those which may have power production or power transference capability. This can also be linked to the previous unit. Students present their findings to the class as a whole, or do this assignment as separate groups each with a specific main type of energy.

Resources

WEB

- CDLI
  - http://www.cdli.ca/courses/ep/predesign/t03.htm
  - http://www.cdli.ca/courses/ep/predesign/t03/02knowledge-skills/act-06a.htm
  - http://www.cdli.ca/courses/ep/predesign/t03/02knowledge-skills/act-07a.htm

NOTES

- Appendix A - Notes section pg. 9

Topic 1 – Types of Energy

Specific Curriculum Outcomes

Students will be expected to

4.1.4 state the first law of thermodynamics [3.402, 3.403]

Suggested Learning and Teaching Strategies

The first law of thermodynamics states that energy can be transferred/converted but cannot be created or destroyed.
A fossil fuel burning in an engine converts its stored chemical energy to mechanical energy through combustion (a chemical process). Some of the energy is converted and lost from the engine to heat, friction, sound and light.
Things to emphasize:

- Energy does not just happen.
- For most alternative energy sources energy comes from a conversion of some sort.

The important aspect of this theory that has to get across to students is that there is no such thing as energy that just happens, everything has a source. From an alternative energy perspective the major energy sources, wind, water and solar all come as a conversion from something else. Wind and water and direct conversions from mechanical energy, whole solar is also partially such a conversion as well as en electrochemical one.

As in all cases of dealing with scientific “fact”, students need to be instructed that this “law” is a theory that is seen as being close to fact, and that as is the case for all scientific knowledge only exists until it has been disproved. A perfect example of this is the fact that the earth was considered flat up until the late 15th century until that theory was disproved. It isn’t expected that the first law will be refuted any time soon, but there is so much we do not understand about our own earth and minds that assuming it will never be disproved is folly.

Student Activity:
Students describe the first law of thermodynamics in their own words, and give concrete examples of how it applies in everyday life.

Topic 1 – Types of Energy

Suggestions for Assessment

Research/Presentation

- Students research the origins of the first law and the succeeding laws of thermodynamics. They should look at the science that lead to these laws and how they were discovered. A presentation on this could be done to the class.

Research/Paper and pencil

- Students explain the first law in their own words, such that the explanation will be able to be understood by a sixth grade student. This can be passed in as a written assignment.

Resources

WEB

- Physics for kids - http://www.physics4kids.com/files/thermo_laws.html
- National Aeronautics and Space Administration (NASA) - www.grc.nasa.gov/WWW/K-12/airplane/thermo1.html
- The NEED project – Putting Energy in Education - http://www.need.org/Guides-Title.php

Topic 2 – Sources of Energy

Specific Curriculum Outcomes

Students will be expected to

4.2.1 describe the most common fossil and alternative fuel [2.404, 3.404]

Suggested Learning and Teaching Strategies

A fuel can be defined as something that can be consumed to produce energy. It is usually, but not always, a factor of combustion. We discuss combustion in the engine section and define it as a chemical process that can be most easily described as 'burning'.
For the purposes of this outcome, we will look at three of the most common fossil fuel types:

- coal
- petroleum distillates
- natural gas

And the most common alternative combustive fuels:

- hydrogen
- natural gas
- propane
- biofuels
- alcohol (ethanol)

Student Activity:

Students could, in small groups or as a whole group, discuss some of the implications

Topic 2 – Sources of Energy

Suggestions for Assessment

Research/Presentation

- Students research one of the fossil fuel or alternative fuel types and make a presentation to the class on their findings. Such things as long term outlook, pollution potential, renewability, ease of use and a variety of other factors should be included in the presentation.

Research/Discussion

- Students research the methodology used in the creation of fossil fuels and discuss how this is done in class. Within this discussion, issues of retaining more of the distillates from the creation of common gasoline should be included.

Resources

TEXT

- *The Solar Hydrogen Civilization*

NOTES

- Appendix A - Notes section pg. 10

Topic 2 – Sources of Energy

Specific Curriculum Outcomes

Students will be expected to

4.2.2 define renewable, non-renewable and inexhaustible with respect to energy sources [2.404, 3.404]

Suggested Learning and Teaching Strategies

Types of energy were covered in the previous topic. At this point the focus will be on energy sources and their method of classification. Historically these sources of energy would only be classified as renewable and non-renewable, but in the past few years the new definition of inexhaustible has further refined how we look at energy and energy generation. The inexhaustible sources require little human intervention beyond the creation and maintenance of machinery to harvest it.

Points to emphasize

- Renewable energy is an energy source than can be sustained over a long period of time, as long as some action is taken to sustain it.
- Non-renewable energy is an energy source that will inevitably run out, has a finite supply.
- Inexhaustible energy is an energy source which will never run out and does not require any intervention to sustain it.

Student Activity:
Students consider the ramifications of the three types of energy sources, and in so doing consider what each of the types mean for the future, and sustainability. This is the first time we will introduce the word sustainability and the full meaning of it and the applicability to this topic should be explored.

Topic 2 – Sources of Energy

Suggestions for Assessment

Research/Presentation

- Students research the origins of the terms presented to them in class. As part of this research they examine the subtle differences between the terms renewable and inexhaustible and how they came into being. Their results could be presented to the class as a whole.

Resources

TEXT

- *The Solar Hydrogen Civilization*

WEB

- Renewable energy sources - http://en.wikipedia.org/wiki/Renewable_energy
- Non-renewable energy - http://en.wikipedia.org/wiki/Non-renewable_resource

Topic 2 – Sources of Energy

Specific Curriculum Outcomes

Students will be expected to

4.2.3 classify the common fossil fuels and alternative fuels as renewable, non-renewable and inexhaustible [2.404, 3.404]

Suggested Learning and Teaching Strategies

Students should be able to classify each of the fuels discussed in the first outcome in this topic. In doing so, they will see one of the reasons that some of the alternative fuels are more palatable than others. All of the fossil fuels are non-renewable, as are natural gas and propane. Renewable energy sources include alcohol, biofuels and to a certain degree hydrogen. Hydrogen would also be considered inexhaustible, as the abundance of it within the oceans, the air and the space around us is beyond measurement.

Points to emphasize

- Fossil fuels are non-renewable resources but some are listed in the alternative fuels section due to their lack of pollutants as a by-product in their combustion.
- All of the discussion to this point has been on fuels and not specifically on direct energy sources, those which do not include a chemical process for energy to be released, but involve direct mechanical processes to do so.
- Hydrogen has applicability as a combustive fuel source and a non-combustive fuel source (hydrogen fuel cells)

Student Activity:

- Students create a classification table of each of the major fuel sources and their relative impact due to their renewability or lack thereof. This will create an excellent lead into the next topic.
- A discussion can occur here about the greatest of the inexhaustible sources, those being the sun, the winds, the tides and geothermal energy.

Topic 2 – Sources of Energy

Suggestions for Assessment

Research/Presentation

- Students research the availability of inexhaustible versus renewable energy resources. In this research they focus on the variety of methods that are used to harness the potential of inexhaustible sources. Their results could be presented to the class as a whole or as a poster.

Research/Discussion

- Students research the different ways non-renewable resources are being supplanted by renewable and inexhaustible sources, and what this means for the environment. A discussion concerning these issues could occur as a result.

Resources

TEXT

- *The Solar Hydrogen Civilization*

WEB

- Sustainability - http://en.wikipedia.org/wiki/Sustainability
- Sustainable Energy - http://en.wikipedia.org/wiki/Sustainable_energy

Topic 2 – Sources of Energy

Specific Curriculum Outcomes

Students will be expected to

4.2.4 become aware of the environmental considerations involved with renewable, non-renewable and inexhaustible energy sources [2.404, 3.404]

Suggested Learning and Teaching Strategies

Environmental considerations for fuels are based on two concepts:

- Sustainability, and
- Impact

How these two considerations relate to renewable, non-renewable and inexhaustible energy sources form the basis of the alternative energy movement.

Points to emphasize

- pollution is one consideration when considering a fuel and engine type. How much pollution is produced and in what form?
- global warming is the second major consideration when considering a fuel and engine type. In this case it is the carbon production and carbon emissions that need to be considered.
- soil degradation is one of the impacts that some renewable energy sources create. The use of farmlands to fast grow crops for the use of alternate fuels has an environmental and societal impact.

Student Activity

- Students review the different fuel types and consider them based on their sustainability, their environmental impact, their pollution potential and their effect on global warming. This could be done in a chart listing each of the fuels and considering what each one produces as a by-product, how it is produced, and other aspects.

Topic 2 – Sources of Energy

Suggestions for Assessment

Research/Presentation

- Students research the concept of sustainability and how it is the cornerstone of environmental activism in some quarters. Looking at sustainability with a lens for economic benefits could also suggest ways that the environment could be protected and businesses could prosper. A presentation on this could be made to the class as a whole.

- Students also research the impact that some of these supposed green plans are having on the environment. A prime example is the use of bio-fuels, which has lead to an increase in the cost of foods world-wide and a shortage of arable land for food production in some countries.

Resources

TEXT

- *The Solar Hydrogen Civilization*

WEB

- Sustainability - http://en.wikipedia.org/wiki/Sustainability
- Sustainable energy - http://en.wikipedia.org/wiki/Sustainable_energy
- Sustainable energy sources - http://www.pc.gc.ca/apprendre-learn/prof/sub/eco/itm7/index_e.asp
- Waste free energy - http://www.epa.gov/waste/education/quest/gloss1a.htm

NOTES

- Appendix A - Notes section pg. 10

Topic 2 – Sources of Energy

Specific Curriculum Outcomes

Students will be expected to

4.2.5 understand the significance of an ecological footprint.

- Calculate what an individual's footprint would be considering their daily energy use.

Suggested Learning and Teaching Strategies

Ecological footprint is a tool that measures how much land and water area is required to produce the resources consumed by an individual and to absorb its wastes using current technology. It is commonly used as a method to show the impact people have on the earth with their consumption methods, driving habits, living conditions and other lifestyle factors.

Individuals can have an impact on the environment around them and this is one way of measuring the extended impact we have. Few consider such things as the distance the food we eat has travelled or the amount of imported goods we buy as having an impact on the environment. But they do, a significant one in some cases.

Points to emphasize

- Ecological footprints are all about sustainability and the impact society is having on the earth
- Energy use is a large aspect of the footprint we make, not only in electricity consumption and fuel use but in the production of the food we eat and clothes we wear.

Student Activity:

- Students go to the Earth Day network site and calculate their ecological footprint. They then compare it to the national footprint for Canada.
- Students vary the aspects of the footprint calculator with respect to energy consumption and investigate what reducing their energy consumption in a variety of ways would do to their ecological footprint.

Topic 2 – Sources of Energy

Suggestions for Assessment

Research/Presentation

- Students research the concept of the ecological footprint, its origins and how it is calculated. A presentation in the form of a poster or to the class as a whole would be appropriate.

- Students also research other aspects of the Earth Day network and what claims they make of what they do to save the planet. These could be weighed against the need for jobs and economic growth in an area.

Role Play

- Students do the ecological footprint challenge in a fictitious manner, portraying themselves as environmentally conscious at every question. they should compare this result with their other results and be able to comment on what this means environmentally speaking.

Resources

TEXT

- *The Solar Hydrogen Civilization*

WEB

- Understanding the footprint - http://www.royalsaskmuseum.ca/gallery/life_sciences/footprint_mx_2005.swf
- How to have a zero footprint - http://www.zerofootprintkids.com/kids_home.aspx
- Ecological Footprint homepage - http://www.myfootprint.org/

Topic 3 – Power and Energy Overview

Specific Curriculum Outcomes

Students will be expected to

4.3.1 Relate the history of technological development dealing with power generation. [3.204, 3.301, 3.302]

Suggested Learning and Teaching Strategies

Technological development of power generation can be summed up by the following headings

- The Age of Wind and Water
- The Age of Steam
- The Age of Electricity.
- The Atomic Age
- Alternative Power

Power generation has evolved as our need for power has changed. In the first age we used wind and water to turn grinding wheels, power tools directly and move ships. As the need for faster transportation developed, the steam age began. Now steam fired machines tilled fields, moved goods and did the work of many men easily. Electric power evolved from the steam age and introduced a variety of labour saving devices, the cable car, electric trains and communications devices.

The atomic age occurred originally as a way to generate electricity more efficiently. As our needs for electricity increased the output from steam generation and hydro-electric stations was quickly maximized. The use of atomic energy for power generation quickly filled the void.

The alternative power age could be seen as moving backwards in some ways. But in this instance, the use of wind turbines, solar cells, tidal power and hydro-electric generation is moving ahead by looking behind.

Student Activity:

Students look at one major technological development in each of the major ages and discuss how this would have changed how things were accomplished.

Topic 3 – Power and Energy Overview

Suggestions for Assessment

Research/Presentation

- In small groups, students concentrate on each of the technological developments specified here and research their origins and breakthroughs in detail. They then present their findings to the class.

Research/Paper and pencil

- Students concentrate on one or more of the energy generation concepts discussed in this section and create an explanation of how it works and where it came from. This explanation could be written so that a child of 10 or 11 could understand it.

Research/Presentation

- Students create a timeline of the major developments in power generation. Each timeline indicates when the technology was developed and where, and give a simple explanation of what the impact was. These could be developed into a poster for the class.

Resources

TEXT

- *The Solar Hydrogen Civilization*

WEB

- Energy in depth - http://www.iptv.org/exploremore/energy/energy_in_depth/sections/timeline.cfm
- Timeline of energy production - http://library.thinkquest.org/C004471/tep/en/general/timeline.html
- Energy timelines - http://tonto.eia.doe.gov/kids/energy.cfm?page=timelines
- History of Energy http://www.earthportal.org/?p=80
- History of Energy - http://www.fi.edu/learn/case-files/energy.html

NOTES

- Appendix A - Notes section pg. 11

Topic 3 – Power and Energy Overview

Specific Curriculum Outcomes

Students will be expected to

4.3.2 examine in detail one specific example of a technological development in power generation. [3.301]

Suggested Learning and Teaching Strategies

This outcome could be accomplished by an independent research project of as a small group project. The intention is to focus on how power generation has evolved in some areas but not in others.

The original generating plants were hydro-electric and steam generating plants. Although the technology used has advanced, the essential underlying concepts in these generations still exist.
The following is a list of possible technological developments that could be used in this outcome.

- Water wheel
- Wind Mill
- Steam Engine
- Alternating Current
- Electric Motor
- Steam Turbine
- Nuclear power generation

Student Activity:
The emphasis on this area is more about what is not being done than what is. Looking at each of the developments, students see that each one is built to a certain degree on the previous iteration, and that some of the most often used devices are just the ones that are most popular.

Topic 3 – Power and Energy Overview

Suggestions for Assessment

Research/Presentation

- Students concentrate on one of the technological developments, research its impact and present their findings to the class as a whole.

Research/Discussion

- Students compare the technological developments listed above and discuss which one had the largest impact on society and the environment.

Resources

WEB

- Waterwheels - http://www.waterhistory.org/histories/waterwheels/
- Illustrated History of Wind Power Development - http://www.telosnet.com/wind/
- Brief History of the Steam Engine - http://www.egr.msu.edu/~lira/supp/steam/
- Water Wheels - http://en.wikipedia.org/wiki/Water_wheel
- Windmills - http://en.wikipedia.org/wiki/Windmill
- Steam engines - http://en.wikipedia.org/wiki/Steam_engine
- AC Current - http://en.wikipedia.org/wiki/Alternating_current
- Electric motors - http://en.wikipedia.org/wiki/Electric_motor
- Steam Turbines - http://en.wikipedia.org/wiki/Steam_turbine
- Nuclear power - http://en.wikipedia.org/wiki/Nuclear_power

VIDEOS

- Video – "Harnessing Energy" a Simply Science video. Available through the Aliant Learning Center - http://learning.aliant.net/
- Video –"Renewing the Resources." CG Kids Series: Toronto, Niagara Falls and Orangeville, Ontario. Available through the Aliant Learning Center - http://learning.aliant.net/

Topic 3 – Power and Energy Overview

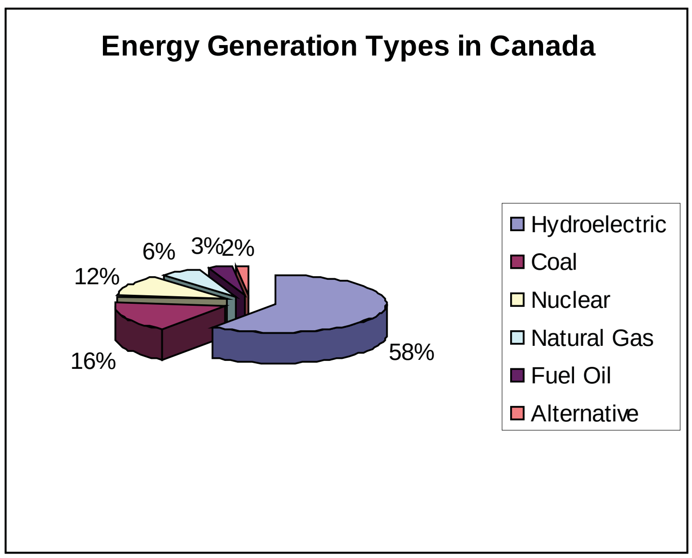
Specific Curriculum Outcomes

Students will be expected to

4.3.3 Identify the main types of power generation technology in use in Canada. [3.301]

Suggested Learning and Teaching Strategies

In 2007, Canada generated some 567 terra-watt hours of Electricity from a variety of sources, broken down in the graphic below. It should be noted that some of the sources are specific and applicable to the province while others are more national. In Newfoundland and Labrador a significant portion of our power generation capacity is found in Hydroelectric and Fuel Oil.



Student Activity:
Students check and see who is the supplier of their electricity and what method is used in its generation. This will be determined regionally overall, and closeness to the type of generation will dictate what is the primary source. A discussion of this in class should be encouraged.

Topic 3 – Power and Energy Overview

Suggestions for Assessment

Research/Discussion

- Students discuss and comment on what the various percentages, representing the generation types, mean with regards to pollution, green-house gases, global warming and other issues surrounding power generation.

Research

- Students compare the major generation types used in this province to those used in the rest of Canada. In so doing they comment on why there is a significant difference between the two.

Resources

TEXT

- *The Solar Hydrogen Civilization*

WEB

- Power Generation in Canada – A Guide - www.canelect.ca/en/Pdfs/HandBook.pdf
- The electricity sector in Canada - http://en.wikipedia.org/wiki/Electricity_sector_in_Canada
- Energy in Newfoundland and Labrador energy sector - http://www.nr.gov.nl.ca/mines&en/industry/overview.stm

Topic 3 – Power and Energy Overview

Specific Curriculum Outcomes

Students will be expected to

4.3.4 describe the common qualities of power generation technology

Suggested Learning and Teaching Strategies

The purpose of this outcome is to make students aware of the commonalities of most power generation technologies. Even with new technology and advances in science, the process of power generation remains much the same as that used hundreds of years ago.

- Step 1 - Water is heated
- Step 2 - Water converts to steam
- Step 3 - The conversion creates high pressure due to the greater space water takes up as a gas in comparison to a liquid
- Step 4 - The high pressure steam drives through a series of pipes and spins a turbine
- Step 5 - Turbine spins an armature within a generator

For our purposes, understanding this process and how the alternative energy sources differ from it would be important at this point. The direct power conversions of hydro electricity (water-turbine-armature) and wind power (wind-turbine-armature) reduce the amount of energy loss in the system and produce electricity directly from a renewable or inexhaustible source. Solar cells create electricity as a process in the photo-voltaic cells, once again a direct conversion.

Student Activity:

Students look at other technologies used in their everyday lives and comment on the ones that have not changed much in the past hundred years or so. Although there are not many, there are some, but few of the complexity of the power generation system.

Topic 3 – Power and Energy Overview

Suggestions for Assessment

Research/Discussion

- Students research the general process of steam-turbine generation and the variations that are used in some of the power generation types.

Research/Presentation

- Students pick one of the common generator types and do a presentation to the class on the methods it uses to create electricity.

Resources

TEXT

- *The Solar Hydrogen Civilization*

WEB

- Power Generation in Canada – A Guide - www.canelect.ca/en/Pdfs/HandBook.pdf

NOTES

- Appendix A - Notes section pg. 12

Specific Curriculum Outcomes

Students will be expected to

4.3.5 review the common qualities of power generation technology and alternative energy production

Suggested Learning and Teaching Strategies

The majority of alternative energy production solutions involve the same practices that are present in all energy production, using something to turn a turbine, that turns and armature within a generator that produces electricity. The only difference lies in how the turbine is turned.

Points to emphasize

- Geothermal energy uses heat from the earth to convert water to steam to turn the turbine.
- Wind turbines are turned by the direct mechanical energy of the wind, thus eliminating the need for heat conversion and the loss of energy associated with it.
- Hydro and tidal power use water to turn the turbines.

Solar energy is the only one which does not use the same sort of processes. Solar energy uses the excitation of atoms in a special matrix called a photo-voltaic cell, to generate electricity directly. This will be discussed in more detail further in the next unit. There are implications from this for the use of solar electricity. With minimal moving parts and no source of power required beyond the sun, solar energy has utility for use in areas the others do not.

Student Activity:

Students relate where they have seen the various technologies in use around the province. Those who live near wind power generation, large or small scale, those who have seen solar in place around the province and so on.

Suggestions for Assessment

Research/Discussion

- Students research the general processes used in alternative energy generation technologies and discuss how these relate to the energy transference section covered before. In this discussion, the reasons why there are similarities between the generation of electricity should be covered.

Research/Presentation

- Students pick one of the common generator types and do a presentation to the class on the methods it uses to create electricity.

Resources

TEXT

- *The Solar Hydrogen Civilization*

WEB

- Overview of alternative energy sources - http://saveenergy.about.com/od/alternativeenergysources/a/altenergysource.htm
- Alternative Energy - http://ocsenergy.anl.gov/documents/fpeis/Alt_Energy_FPEIS_Chapter3.pdf
- Power Generation in Canada – A Guide - www.canelect.ca/en/Pdfs/HandBook.pdf

Unit 5: Experiencing Alternative Energy Modularly

Unit 5 Overview

The purpose of this unit is to provide students with an introduction to alternative energy experientially. The use of modules in this instance is to ensure that all students have an equal opportunity to access the equipment in question. The hands-on activities are designed to give students access to a full range of the available technologies in the area of alternative energy production. As stated before, these technologies will involve a significant amount of electrician methodology and will, in the future, be a major determinant in the field. Students will learn how to operate tools and machinery specific to the power and energy world. They will learn to use them properly and safely within the fabrication lab environment. The teacher takes on more of a facilitation role in these instances, working with individual student groups in an advisory role. It is suggested that the teacher introduce the modules to all students and review them periodically so that students are prepared for what they will be doing.

Organization

The purpose of this unit is to give students an introduction to and practical working knowledge of alternative energy production. This is a pure example of theory into practice. The previous unit introduced the theoretical while this unit emphasizes the practical. This entire unit will be encompassed by a design process, with an implementation design as its final project.

The following unit topics will provide these experiences:

- Topic 1: Design for Construction (2 hours)
- Topic 2: Windmill Technology (8 hours)
- Topic 3: Solar Cell Technology (8 hours)
- Topic 4: Service Panel Wiring (8 hours)
- Topic 5: Hydrogen Fuel Cells (8 hours)
- Topic 6: Heat Pump Technology (8 hours)
- Topic 7: Sustainable Housing (8 hours)

Assessment

This section constitutes approximately 40% of the course time and the value attributed to it should reflect that status. It is expected that most of the assessment opportunities in this section will involve hands-on activities and assessment tools dealing with observation and experiential learning will be the most effective.

Topic 1 – Design for Construction

Specific Curriculum Outcomes

Students will be expected to

5.1.1 identify the steps in the design process [1.401]

Delineation

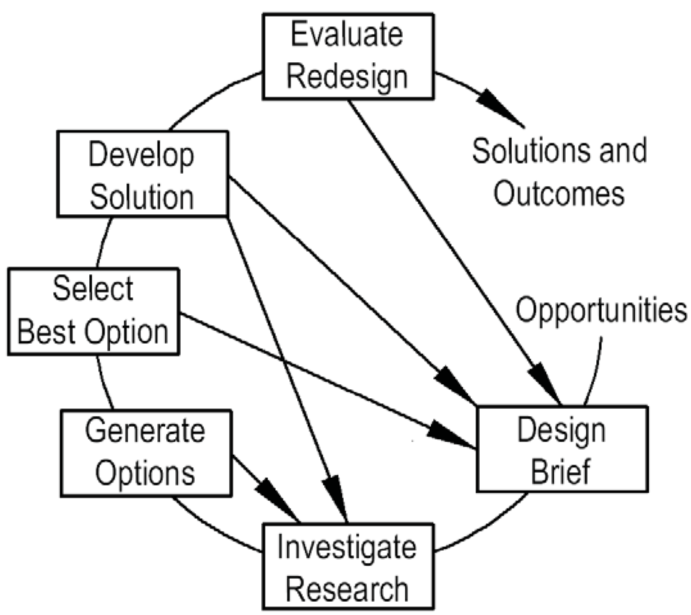
The discussion should focus on:

- Needs identification
- Defining the Problem
- Generating Options
- Selecting the Best Option
- Developing the Solution
- Prototyping and Testing
- Evaluation and Redesign

Suggested Learning and Teaching Strategies

It is essential in any design that the student be familiar with the steps in the design process and their relation to construction or renovation. This differs from fabrication because of the limitations it introduces. Normally in fabrication the only limitation is tooling and space. In this instance the limitations are resultant from the size of the structure and how the solutions can be introduced within it.
Using a case study example, the teacher should discuss the concepts of renovation and construction and how each introduces different constrictors in the process of design.
The teacher must also introduce the concept of problem solving in both individual and group environments and the related advantages/disadvantages in each case.

The Design Process can be encapsulated in the following diagram.



Topic 1 – Design for Construction

Suggestions for Assessment

Paper and pencil

- Students develop a poster outlining the steps of the design process. This poster could be complete with examples of the various stages of a product in design.

Presentation

- Students present to the class their interpretation of the design process in their own words.

Paper and pencil

- Students outline and explain the steps of the design process. This outline should include language such that a student in grade 4 or 5 would understand what was being explained.

Discussion

- Students debate and discuss the order of the steps of the design process. Links to the scientific method and other problem-solving approaches should be introduced here.

Resources

TEXT

- *Design and Fabrication 1202 Curriculum Guide*
- *Design and Fabrication 2202 Curriculum Guide*

WEB

- The Technology Student - http://www.technologystudent.com/designpro/despro1.htm
- Nuclear Engineering Site - http://www.nuceng.ca/ep716/chap7.pdf
- Robotics Design Process - http://www.galileo.org/robotics/design.html

Topic 1 – Design for Construction

Specific Curriculum Outcomes

Students will be expected to

5.1.2 apply the design process in the design of a simple alternative energy implementation [1.402, 1.403]

Suggested Learning and Teaching Strategies

The design in this instance is very specific and can be very practical. Designing for construction is centered around making something work in an existing design or an existing structure. Many houses are being designed with alternative energy solutions in mind, but few are designed around them. These specific designs can be discussed in class and examples of such shared, but the more practical design for renovation and/or construction should form the basis of the design challenge.

This objective has the capability of becoming very practical not only in class but in the student's own experience. Most of these alternate energy solutions are readily available through local hardware stores and being able to calculate the benefits of such while designing an implementation into an existing or new structure will have value.

The remainder of the outcomes in this section will give the student some practical experience with the alternative energy products that will be part of the designed solution. Students should identify what sort of solution they are designing for, an existing structure or a new build. Floor plans and general layouts of the structures should be either procured or drawn. The next stages of the design should include the discussion of what is easily possible in the situation the students have identified.

Cost of implementation, cost of operation and savings possible (if any) should all enter into the process. Alternative energy solutions tend to have large capital outlays with savings being realized in operating costs over a number of years.

Topic 1 – Design for Construction

Suggestions for Assessment

Practical activity

- Students begin the design of their alternative energy solution. At this juncture, the type of structure for implementation, a suggestion of what types of alternative energy could be used and an estimate of cost should be included.

Design Portfolio

- Students create a design portfolio at this point. This portfolio will contain all of the designs, design elements, meeting notes and drawings that students will have undertaken in this section of the course. The portfolio could be paper-based, digital or some other media that students will feel comfortable reporting in.

Research/Presentation

- Students research the installed costs of various alternative energy solutions, as well as their proposed savings over a period of years. A cost-benefit analysis is undertaken, taking into account long-term maintenance costs as well. This could be presented to the class or as a poster for display in the fabrication lab.

Resources

TEXT

- *Design and Fabrication 1202 Curriculum Guide*
- *Design and Fabrication 2202 Curriculum Guide*

WEB

- The Technology Student - http://www.technologystudent.com/designpro/despro1.htm
- Nuclear Engineering Site - http://www.nuceng.ca/ep716/chap7.pdf
- Robotics Design Process - http://www.galileo.org/robotics/design.html

Topic 1 – Design for Construction

Specific Curriculum Outcomes

Students will be expected to

5.1.3 review the legislation dealing with the use of windmill and solar power generation methods in Newfoundland and Labrador [1.405]

Suggested Learning and Teaching Strategies

The purpose of this outcome is to introduce the legislative requirements for dealing with aspects of alternative energy production. The two types of energy production specifically are wind and solar which have the capability of producing electricity directly.

There is no specific legislation dealing with wind and solar power generation, but power generation in general is covered under the Newfoundland and Labrador Hydro Act. That act gives an absolute monopoly for power generation to Newfoundland and Labrador Hydro. No other company or individual can add power to the grid unless they first sell it to Hydro. Some inferences can also be made from the Provincial Energy Plan and the "2009 Lower Churchill deadline". There are references to this in the notes section found in appendix A

From an small energy production perspective

- Utilities are governed by the PUB. Only registered utilities can sell power to customers and rates are set by the PUB for classes of electrical users.
- Individuals or companies do not have to be a utility to produce electricity but can only sell it to a utility.
- On-the-grid facilities are not permitted to include personally owned alternative solutions at the same time unless inspected and approved by the utility.
- Off-the-grid facilities have no barrier to use, beyond the restriction of who excess power can be "sold" to.

Student Activity:

Students discuss what these legislative powers could mean to personal use of windmill power generation.

Topic 1 – Design for Construction

Suggestions for Assessment

Research/Presentation

- Students define the difference between an economic limit and a technical limit. In the process they could discuss what is needed in the province to make these higher.

- Students research the role of the Public Utilities Board in power generation and regulation. In the process they also research who is on the board and who they represent.

Resources

WEB

- Newfoundland and Labrador Government Energy Plan - http://www.nr.gov.nl.ca/energyplan/
- Energy Corporation Act - http://assembly.nl.ca/Legislation/sr/statutes/e11-01.htm
- Newfoundland and Labrador Government Energy Plan - http://www.nr.gov.nl.ca/energyplan/
- Electrical Power Control Act - http://assembly.nl.ca/Legislation/sr/statutes/e05-1.htm
- Public Utilities Act - http://assembly.nl.ca/Legislation/sr/statutes/p47.htm

NOTES

- Appendix A - Notes section pg. 14

Topic 2 – Windmill Technology

Specific Curriculum Outcomes

Students will be expected to

5.2.1 review and demonstrate proper safety procedures when working with a wind turbine power generation system [1.405]

Suggested Learning and Teaching Strategies

Windfarms are extremely safe and are designed for life of at least 20 years in all weather extremes. All major manufacturers use international safety standards in turbine design, which allows for complete shut down during times of excessive wind speeds. Turbines should have a "survival speed" brake system. (turbine spins above set speed and it automatically shuts down)
Wind turbines produce no harmful emissions in their generation of electricity, as they have a direct mechanical energy transfer system in most cases. Most modern turbines use lightning-protection systems engineered to direct lighting safely to the ground.
Safety issues during construction include working at heights in windy conditions, working with cranes, heavy machinery, rotating machinery, and high voltage. Mounting turbines to a roof top is not recommended unless it is a small unit (1 kW of rated output or less). Turbines tend to vibrate and transmit this vibration to the structure resulting in damage to the structure.

For the specific purpose of safety in this course, students will be working with electricity and the wind turbine.
Points to emphasize

- A wind turbine must be treated with respect at all times, and no movement should be undertaken unless the brake is engaged.
- Any time the turbine is in operation it must be properly guarded or isolated in such a way as to be clear of obstructions and/or accidental contact
- Electricity safety is covered in Skilled Trades 1201 and the Technology Education Safety Guide. These documents should be heavily referenced before students are engaged in an electrical activity.

Topic 2 – Windmill Technology

Suggestions for Assessment

Research/Presentation

- Students research working safe websites, dealing with rotational machinery, as well as their own fabrication lab safe tool use for machinery that has common features with a windmill, and create a list of safe work rules dealing with windmill technology. This could be presented to the class or passed in as an assignment.
- Students review the safety precautions in place when working with electricity and extrapolate them for use in this area. A poster for safe windmill technology use could be created or this could be entered into their work log.

Discussion

- Students search the Nalcor Energy website for examples of safety procedures used in their generating facilities. A search of other windmill generating stations and their websites may contain further information. A small group or class discussion around this topic could ensue.

Resources

TEXT

- *Progressive Education Alternative Education Teacher's Guide*
- *Progressive Education Alternative Education Student Manual*

WEB

- Wind Turbine FAQ - http://www.hybridynepower.ca/Page_80.02.htm
- Renewable Energy UK - http://www.bwea.com/ref/faq.html
- How safe is Wind Energy? - http://wiki.answers.com/Q/How_safe_is_wind_energy

VIDEO

- Wind Turbine Setup - Skilled Trades and Technology Professional Learning Video Series

Topic 2 – Windmill Technology

Specific Curriculum Outcomes

Students will be expected to

5.2.2 outline the historical use and development of windmill technology [1.405]

Suggested Learning and Teaching Strategies

The current interest in wind energy was started by the need to develop clean, sustainable energy systems that can be relied on for the long-term future. But wind energy has been used in a variety of ways for centuries. This section should encompass the breadth of that use, including the specific high points of:

- circa 500 BC - Persians used wind energy to pump water
- circa 1000 - wind-driven ships start to explore the world
- circa 1500 - Dutch use wind energy to drain marshes and lakes
- 1920's - over a million wind turbines pumped water and provided electricity to farms in North America

Wind turbines now provide reliable, cost-effective, pollution-free energy for individual, community, and national applications.

Student Activity:

- Students develop a timeline of windmill technology, emphasizing the high points of its use in history. Comments could be made at each of these points as to how these developments have lead to the modern wind turbine.

5.2.3 describe the planned wind-farm technology to be used in Newfoundland and Labrador [1.404, 1.405, 2.404]

This outcome is intended to make students aware of the great potential this province has to be a leader in alternative power generation. Many are aware of the potential and already developed projects on the Churchill River, but wind is another untapped resource. An examination of the wind atlas of Canada, indicates that Newfoundland and Labrador is one of the best areas in the country for windfarming. Almost all of our coastal areas have sufficient and consistent wind speeds to sustain a windfarm. Several projects have been initiated to test the viability of producing electricity in this way.

Along with these projects, test and pilot sites around the province are being used to examine methods to provide

Topic 2 – Windmill Technology

Suggestions for Assessment

Research/Presentation

- Students research some of the reasons why windmills were used and how they have developed into a major alternative energy solution.

Discussion

- Students discuss, in small groups or as a class, how some of the historical uses for windmills may still have applicability today. These could include but are not limited to, pumping water, driving machinery, etc.

Research/Assignment

- Students research the planned wind farms to be used in the province and create maps that show their location. These could be compared to maps of the prevailing winds in Newfoundland and Labrador as a method to discover why they were placed at their location.

Resources

TEXT

- *Progressive Education Alternative Education Teacher's Guide*
- *Progressive Education Alternative Education Student Manual*

WEB

- Wind Energy History - http://www.thesolarguide.com/wind-power/history.aspx
- History of Wind Energy - http://www1.eere.energy.gov/windandhydro/wind_history.html
- History of Wind Power - http://www.windturbinesnow.com/history-wind-power.htm

NOTES

- Appendix A - Notes section pg. 14

WEB

- Newfoundland and Labrador Government Energy Plan - http://www.nr.gov.nl.ca/energyplan/

NOTES

- Appendix A - Notes section pg. 14

Topic 2 – Windmill Technology

Specific Curriculum Outcomes

Students will be expected to

5.2.3 describe the planned wind-farm technology to be used in Newfoundland and Labrador [1.404, 1.405, 2.404] (cont'd)

Suggested Learning and Teaching Strategies

consistent power from wind, which even in this province is not always of sufficient speed to generate electricity.

Within the notes section in the appendix is an overview of the specifications of these new projects. The amount of CO_2 produced versus the amount of energy produced would be an area to highlight.

Student Activity:

- Students compare this amount of greenhouse gas reduction to the amount a typical family would produce in a year (2 tons). This comparison can include aspects of the "1 ton challenge" (an initiative of Environment Canada) and how such an energy solution could enable a global reduction in the production of greenhouse gases.

5.2.4 determine the proper placement for a wind turbine, taking into account wind gusts, placement, safety and other considerations [1.402, 2.401, 2.404]

Two important factors when setting up a wind turbine are the amount of energy needed and the amount of wind available. Students could refer to Environment Canada's Wind Atlas for the latter. Their maps graphically show available winds for all regions in Canada and at different elevations, http://www.windatlas.ca/en/index.php

Points to emphasize

- wind consistency
- noise
- proper safety such as fencing and signage
- environmental impact
- zoning, and
- aesthetics

Basic system will include a turbine, a controller, a battery bank, an inverter to provide AC output.

Students should consider all of the above when placing their wind turbine.

Student Activity:

- Students place a wind turbine, taking into account the major factors for maximum generation potential.
- Students compare output from the wind turbine with output from the weather station in their schools.

Topic 2 – Windmill Technology

Suggestions for Assessment

Practical Activity

- Students, over a number of classes, determine the prevailing wind direction around their school. This can be accomplished through taking measurements, collecting data from the school weather station, from internet weather sites or from Environment Canada. A chart of the wind directions around the school could be completed.
- Students examine the footprint of their school and determine the safest place that a wind turbine could be set up.

Resources

TEXT

- *Progressive Education Alternative Education Teacher's Guide*
- *Progressive Education Alternative Education Student Manual*

WEB

- Best Places to put a Wind Turbine to Produce Electricity - http://www.ehow.com/way_5159049_places-wind-turbines-produce-electricity.html
- Canadian Wind Atlas - http://www.windatlas.ca/en/maps.php
- Picking the best location for a wind turbine - http://www.omafra.gov.on.ca/english/engineer/facts/03-047.htm#location

Topic 2 – Windmill Technology

Specific Curriculum Outcomes

Students will be expected to

5.2.5 monitor wind turbine efficiency by comparing output to general daily wind speeds or to artificial variations to account for same [2.401, 2.404]

Suggested Learning and Teaching Strategies

German physicist Albert Betz proved in 1919 that the highest efficiency possible from a wind turbine is around 59%, and this is really unattainable given other constraints. This became known as Betz Law.
Efficiency is a mathematical relationship that is sometimes expressed as

input/output x 100%

A given turbine has a "design point" that defines its peak efficiency at the wind speed for which it is designed. For speeds above and below the design point the efficiency will be the same or less.
Data loggers can be used to measure the power output & efficiency of the turbines using various sensors. Typical sensors include, but are not limited to:

- anemometers,
- wind vanes,
- temperature sensors,
- solar radiation,
- electrical current,
- resistance,
- power, and
- voltage.

Student Activity:

- Students construct a performance curve of power output versus wind speed that can then be used to measure efficiency.
- Students also compare this efficiency to the "design point" efficiency of the wind turbine in use. Part of this task includes finding the "design point" efficiency.

Topic 2 – Windmill Technology

Suggestions for Assessment

Practical Activity

- Students, using the in-class wind turbine assembly, monitor wind turbine efficiency at different wind speeds. As well, they can check the efficacy using the load device. An assignment or series of log entries on this material would be suggested.

Research/presentation

- Students research material on measuring wind speeds, and in so doing, create a system where the speed of wind can be measured and compared to the output of a wind turbine. The weather station, in use in many schools, has specific utility here.

Research/Practical Activity

- Students, using the load device, test the effects of using compact fluorescent bulbs instead of incandescent bulbs. This could be compared to claims made by the manufacturers as to which uses less energy long term.

Resources

TEXT

- *Progressive Education Alternative Education Teacher's Guide*
- *Progressive Education Alternative Education Student Manual*

WEB

- Wind Turbines and the Energy in Wind - http://www.ftexploring.com/energy/wind-enrgy.htmlCanadian Wind Atlas - http://www.windatlas.ca/en/maps.php
- Wind Energy Planning - http://www.windenergyplanning.com/wind-turbine-efficiency/
- Wind Turbine Efficiency 101 - http://windturbinesforsale.net/wind-turbine-efficiency-101/

Topic 3 – Solar Cell Technology

Specific Curriculum Outcomes

Students will be expected to

5.3.1 review and demonstrate proper safety procedures when working with a solar cell power generation system [1.405]

Suggested Learning and Teaching Strategies

Unlike many technologies used for the generation of electricity, the solar cell (photovoltaic cell) does not contain any visibly moving parts. Photovoltaic is the direct conversion of sunlight into electricity at the atomic level. Based on the photoelectric effect first observed in 1839 and later made famous by Albert Einstein in 1905, it results from the fact that certain materials absorb photons and release electrons, thus forming an electric current.

Due to the fact that there are no moving parts, and that from each separate cell only a little current is produced, it is generally the safest alternative energy generation method. The solar cell is actually a number of photovoltaic cells working in tandem. The amount of electricity generated from it gets larger for each cell added.

Safety concerns for the solar cells exist around breakage hazards, falling hazards and electrical hazards. For the specific purpose of safety in this course, students will be working with electricity and solar cells.

Points to emphasize

- A solar cell must be treated with respect at all times, risk of shattering can occur if the cell is mishandled.
- Any time the cell is in operation it must be placed in such a way as to be clear of obstructions and/or accidental contact.
- Electricity safety is covered in Skilled Trades 1201 and the Technology Education Safety Guide. These documents should be heavily referenced before students are engaged in an electrical activity.

Topic 3 – Solar Cell Technology

Suggestions for Assessment

Research/Presentation

- Students research working safe websites, dealing with electrical production machinery, as well as their own fabrication lab safe tool use for machinery that has common features with a windmill, and create a list of safe work rules dealing with windmill technology. This could be presented to the class or passed in as an assignment.
- Students review the safety precautions in place when working with electricity and extrapolate them for use in this area. A poster for safe windmill technology use could be created or this could be entered into their work log.

Discussion

- Students search the Nalcor Energy website for examples of safety procedures used in their generating facilities. A search of other windmill generating stations and their websites may contain further information. A small group or class discussion around this topic could ensue.

Resources

TEXT

- *Progressive Education Alternative Education Teacher's Guide*
- *Progressive Education Alternative Education Student Manual*

WEB

- Solar Panel FAQ - http://www.solarhome.org/solarpanelsfaqs.html
- Solar Power Kits - http://poweredbysolarpanels.com/industry/solar-power-kits/

VIDEO

- Solar Cell Setup - Skilled Trades and Technology Professional Learning Video Series

Topic 3 – Solar Cell Technology

Specific Curriculum Outcomes

Students will be expected to

5.3.2 outline the historical use and development of solar cell technology [1.405]

Suggested Learning and Teaching Strategies

The underlying theory behind the solar cell is the photoelectric effect. This section is most effectively covered by using independent research or a time-line approach.
In either case there are certain high points that should be covered:

- 1839 - discovered in by Edmund Bequerel
- 1905 - further refined and described by Albert Einstein
- 1958 - first actual module built by Bell Laboratory
- 1960's - space race - satellites and capsules used them for a power source, technology refined
- 1970's and 80's - energy crisis - further refined, became more mainstream.
- 1980's and 90's - technology advances for home use

The technology continues to advance and decrease in price. As costs for other methods of lighting and heating a home continue to increase, the attractiveness of this alternative will also increase.

Student Activity:

Students be engaged in practical activities at this point, relating examples of how solar cells have become more mainstream from their own lives. Solar cells used for toys, RVs or home that are available at the local hardware store are one example.

Topic 3 – Solar Cell Technology

Suggestions for Assessment

Research/Presentation

- Students research some of the reasons why solar cells were used and how they have developed into a major alternative energy solution.

Discussion

- Students discuss, in small groups or as a class, how some of the historical uses for solar cells and in particular gathering energy from the sun, may still have applicability today. Such things as heating and cooling the air in a structure would be a good place to start.

Assignment

- Students research how solar cells work then write them in an explanation such that a ten year old could understand it. This assignment could be passed in or entered into a portfolio or work log.

Resources

TEXT

- *Progressive Education Alternative Education Teacher's Guide*
- *Progressive Education Alternative Education Student Manual*

WEB

- Photovoltaics History Timeline - http://inventors.about.com/od/timelines/a/Photovoltaics.htm
- The History of Solar - http://www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf
- Solar History 101 - http://www.gosolarcalifornia.org/solar101/history.html
- Wikipedia - http://en.wikipedia.org/wiki/Solar_cell

NOTES

- Appendix A - Notes Section

Topic 3 – Solar Cell Technology

Specific Curriculum Outcomes

Students will be expected to

5.3.3 describe common usages for solar cell technology in Newfoundland and Labrador [1.402,1.405, 2.401, 2.404]

Suggested Learning and Teaching Strategies

Solar cells are in use all around Newfoundland and Labrador. The technology provides power that can be used to run devices as well as stored in batteries. The most seen use for the technology is the interpretation centers on the highway going through Terra Nova National Park. These centers have lighting and some small devices in use that require power. Rather than running electrical lines and wires through the pristine environment, Parks Canada used solar cell technology to power these devices. Transport Canada used solar cells to power isolated lights and buoys that are in place for navigation. Solar technology is being tested as a power source for isolated communities. The examples listed are a good cross-section of the many areas it is in use, and may suggest to students other areas the solar cell may have applicability.

Points to emphasize

- Places where solar cells have the greatest use are those which running electrical wire is impractical
- Most of the solar cell technology in use in Newfoundland and Labrador has been for government use.
- As cell technology decreases in price it is expected that the number of uses in the private sector will also increase.

Student Activity:

- Students outline the areas which they feel solar cell technology could be used in Newfoundland and Labrador.
- Students research the areas solar cell technology is currently in use in Newfoundland and Labrador.

Topic 3 – Solar Cell Technology

Suggestions for Assessment

Research/Assignment

- Students research solar cells as currently used in the province and create maps that show the locations. Discussions of why they were used in this instance could occur, as well as a written assignment.

- Students take the list they have created of areas they feel solar cell technology could be used for, and compare it to a list of those places that are currently using it. A discussion could ensue as to why the two lists are different or the same.

- Students research the use of other types of solar technology in the province, those that do not include solar cell technology. This could be completed as an assignment, or presented to the class as a whole.

Resources

WEB

- A Solar Cell Home In Newfoundland and Labrador - http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V4S-4967CX7-1&_user=10&_coverDate=02%2F29%2F2004&_rdoc=1&_fmt=high&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1313184066&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=eb585a6f6a4c51d68c5e2229dcb2b76d
- Cross Canada in a Solar car - http://www.engineering.com/Library/ArticlesPage/tabid/85/articleType/ArticleView/articleId/84/Cross-Canada-in-a-Solar-Car.aspx
- Newfoundland Power - http://www.newfoundlandpower.com/KidZone/eew/learn/make.html

Topic 3 – Solar Cell Technology

Specific Curriculum Outcomes

Students will be expected to

5.3.4 set-up a solar cell, taking into account sunlight exposure, angle, placement, safety and other considerations [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

Solar cell arrangements have to be set up to capture the most sun to be of the most benefit. To do this effectively there are several items to consider:

- The direction of the cell
- The hemisphere you are in
- The season
- The angle of the sun

To be most effective, solar cells cannot be fixed year round. The have to be able to be adapted depending up the season. Generally all solar panels in the northern hemisphere will point south. In the southern hemisphere they would point north. This direction does not change, but the tilt of the panel itself, how far it is from horizontal will.

There are two methods of dealing with this effect, one is the simple one of changing the tilt of the solar cell as the seasons change. There are many charts showing the angle of the sun, and simple calculations that can be done to determine the best orientation. The general rule of thumb for this orientation is that you take your latitude plus 15° for winter and minus 15° for summer.

The second way of dealing with this effect is to use a sun-tracking system. This automated system will track the sun and using motors adapt the angle and position of the solar cell as needed. For the purposes of this course we will be dealing with the manual method.

Finally the last consideration for placement of the solar cell is a simple one, shade. Cells should be placed such that they are exposed to sun at all times, not shaded at any time.

Student Activity:

- Students research the tilt angles of solar cells to determine

Topic 63– Solar Cell Technology

Suggestions for Assessment

Practical Activity

- Students, over a number of classes, determine the best direction around their school for taking in sunlight. This can be accomplished through taking measurements, collecting data from the school weather station, from internet weather sites or from Environment Canada. A chart of the solar path around the school could be completed.
- Students examine the footprint of their school and determine the best and safest place that a solar cell could be set up.
- Students place a solar cell outside their school. They should take into account:
  - the direction the cell should point;
  - the season; and
  - the angle of the sun.

Resources

TEXT

- *Progressive Education Alternative Education Teacher's Guide*
- *Progressive Education Alternative Education Student Manual*

WEB

- Solar Panel FAQ - http://www.solarhome.org/solarpanelsfaqs.html
- Solar Power Kits - http://poweredbysolarpanels.com/industry/solar-power-kits/
- Solar Research - http://www.nrel.gov/solar/

LEARNING MATERIALS

- Progressive Education System Solar Cell Apparattus

VIDEO

- Solar Cell Setup - Skilled Trades and Technology Professional Learning Video Series

Topic 3 – Solar Cell Technology

Specific Curriculum Outcomes

Students will be expected to

5.3.4 set-up a solar cell, taking into account sunlight exposure, angle, placement, safety and other considerations [1.402, 2.401, 2.404]

(cont'd)

Suggested Learning and Teaching Strategies

whether the rule of thumb actually is the optimum method for determining the angle.

- Students calculate the angle the cell should be placed at for different latitudes in Newfoundland and Labrador. These angles can be plotted on a graph or map to show the differences.
- Students use information from the weather station on their schools to determine the sunniest times of the year. This data could be used to determine the best times to deploy a solar cell.

5.3.5 wire a solar cell into a solar charge controller and green meter panel [1.402, 2.401, 2.404]

The two devices to be wired are integral to the process of wiring off the grid. The charge controller keeps a steady charge in place, while the green meter indicates cost savings. The final piece would be a charge inverter to permit DC-AC conversion. The three devices together create a functional system that will allow for normal power use while ensuring proper charging and indicating savings. Off-the-grid as discussed previously is the easiest application for this technology. If no other power sources are available then legislative questions do not arise.

Other scenarios in this area should also be explored, namely the partial off-the-grid solution and the on-the-grid solution. The partial solution would mean that one distinct part of the power use in a home would be isolated from the main. That part would then be supplied through an alternative solution.

The on-the-grid solution would require a sign-off from an electrician. In this case you are using the alternative solution to off-set the amount of electricity you are using on a grid. Inspections of such a solution are necessary, but the legislation governing their use has not as of yet been developed.

Topic 3 – Solar Cell Technology

Suggestions for Assessment

Practical Activity

- Students attach a solar cell to the charge controller and battery assembly. This could be done on a group per group basis or done once as a whole class demonstration.

- In small groups, students use the bench-top trainer for solar cells and examine how they are wired into a charge controller and how they are wired internal to the solar cell assembly as well.

Resources

TEXT

- *Progressive Education Alternative Education Teacher's Guide*
- *Progressive Education Alternative Education Student Manual*

WEB

- Solar Panel FAQ - http://www.solarhome.org/solarpanelsfaqs.html
- Solar Research - http://www.nrel.gov/solar/

LEARNING MATERIALS

- Progressive Education System Solar Cell Apparattus

VIDEO

- Solar Cell Setup - Skilled Trades and Technology Professional Learning Video Series

Topic 3 – Solar Cell Technology

Specific Curriculum Outcomes

Students will be expected to

5.3.6 monitor solar cell efficiency by comparing output to sunshine availability [1.402, 2.401, 2.404]

Suggested Learning and Teaching Strategies

This outcome also links the weather station installed in all high schools with the solar cell. Using data from the weather station on sunshine availability, also visual data of the sky, a measurement of the output of the solar cell can be taken and compared to this other data.

Points to emphasize

- Solar cells will produce electricity even when it is cloudy.
- The amount of sunlight that is available should be compared to the output from the panel
- Output from the panel should be measured on the green meter
- Tilt and placement will also have to be taken into effect when working on this section

Student Activity:

- Students graph the output of the solar cell to the sunshine availability and plot a light vs electricity graph. Simple experiments can also be carried out on this using a high intensity flash light.

- Students discuss and comment on the variability of sunlight availability in Newfoundland and Labrador and what this may mean for solar cell use in this province.

Topic 3 – Solar Cell Technology

Suggestions for Assessment

Practical Activity

- Students, using the solar cell assembly, monitor solar cell efficiency at different sunlight levels. As well, they can check the efficacy using the load device. An assignment or series of log entries on this material would be suggested.

Research/Assignment

- Students research material on measuring sunlight levels, and in so doing, create a system where the amount of sunlight can be measured and compared to the output of a solar cell. The weather station, in use in many schools, has specific utility here.

Research/Practical Activity

- Students, using the load device, test the effects of using compact fluorescent bulbs instead of incandescent bulbs. This could be compared to claims made by the manufacturers as to which uses less energy long term.

Resources

TEXT

- *Progressive Education Alternative Education Teacher's Guide*
- *Progressive Education Alternative Education Student Manual*

WEB

- Solar Cell Efficiency - http://www.pvsociety.com/hottopic/Solar_Cell_Efficiency/
- Efficiency - http://www.renewableenergyworld.com/rea/news/article/2007/07/from-40-7-to-42-8-solar-cell-efficiency-49483

MATERIALS

- Progressive Education System WSEM -400 Wind/Solar Apparattus
- Heathkit RES-100 Solar/Fuel Cell Experiment Materials

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Specific Curriculum Outcomes

Students will be expected to

5.4.1 describe the components and function of a standard residential electrical service [1.405]

Suggested Learning and Teaching Strategies

The service is made up of a number of key components.

- Main hot bus
- Neutral bus bar
- Ground Wire
- Main Power switch
- Breakers
- GFI Breakers

Each of these components has a function and these should be covered in detail.

Considering the practical nature of this course, the teacher could use the materials supplied to do a practical demonstration of what each of the terms is and how it would look. Then each of the components can be broken down and described as part of their function in the residence. At this time introducing changes that have happened to the electrical service would be useful. Fuses should be discussed at some point as students may be familiar with their function as well.

At no time should students be in close proximity to an operating panel with the panel cover off, unless they are in the presence of a certified electrician.

Student Activity:

Students create a flowchart as a class or in small groups that shows how electricity flows from the main service mast into the residential service and then into individual circuits.

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Suggestions for Assessment

Research/Assignment

- Students create a table with two columns, listing the following items in column 1, describing the purpose/function of each of the items in column 2.
    - Breakers and fuses
    - Wires, (types and sizes)
    - Octagon and outlet boxes
    - GFCI
    - Neutral Bus Bar
    - Main Hot Bus
    - Ground Wire
    - Main Power switch
- For each of the items, examine the device and determine how wire is connected.

Work log

- Students create an entry outlining the information they have learned, in their work log.

Guest speaker

- Students invite a guest speaker to class who is a certified electrician. Each student could develop a question to ask of the guest speaker before the come to class and be responsible for not only asking the question but recording the answer to report back to the class.

Resources

TEXT

- *Skilled Trades 1201 Curriculum Guide*
- *Smart Guide To Wiring*
- *Modern Carpentry* - Chapter 26
- *Carpentry & Building Construction* - Unit 8, Chapter 39

WEB

- Electrical Safe Work Practices - http://www.aps.anl.gov/About/Committees/Electrical_Safety_Committee/ElectricalSafeWorkPractices.htm

VIDEO

- Hometime Video Collection (Hometime Video Publishing Inc.) - How-To Guide to Plumbing and Electrical

NOTES

- Appendix A - Notes Section pg. 15

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Specific Curriculum Outcomes

Students will be expected to

5.4.2 demonstrate safe practices for use of tools and test equipment common in the installation of an electrical service [2.401][2.402] [2.405] [3.401][5.402]

Suggested Learning and Teaching Strategies

Before permitting students to work independently there are a number of demonstrations that must be accomplished.

Points to emphasize:

- Building code requires that the mast be of a certain size, type of material, distance above the finished grade.
- The meter socket be located 6 feet above the finished grade of the lot and properly grounded.
- The service panel must be located 5-6 feet above the finish floor and specific code requirements regarding how and where it is to be located.
- In most houses today the majority of the service electrical components are made from non conducting materials like plastic, adequate grounding must be provided through suitable ground wiring and the main water supply for the house.

The main service conductors are large copper cables that may be cut to size using a hack saw. Plastic insulation is removed using a utility knife of pocket knife and are inserted into lugs designed to hold the cables snug to prevent arching.

Student Activity:

As a homework activity, students should examine and sketch their home mast and service panel to ascertain where on the house it is located, what sort of fault interuption is present, where in the house it is located and whether there might have been a better place to install the panel.

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Suggestions for Assessment

Only 100% on the written and performance components of the test for each tool is acceptable.

Pencil and Paper

- Assess tool safety and use with Tool Safety Quizzes from Skilled Trades Safety Guide. This is assessment for learning, and students must repeat the quizzes until 100% is attained. No tool use is permitted before successful completion of the quizzes.

Practical Activity

- Students must demonstrate the safe and proper operation of the following tools and devices:
  - Wire cutters
  - Wire strippers
  - Multimeter
  - Circuit tester
  - Screwdrivers

Work log

- Students create an appropriate entry in the worklog itemizing the tools they have qualified for.

Resources

TEXT

- *Skilled Trades 1201 Curriculum Guide*
- *Smart Guide To Wiring*
- *Modern Carpentry* - Chapter 26
- *Carpentry & Building Construction* - Unit 8, Chapter 39
- *Skilled Trades and Technology Safety Guide* - Safety Test Appendix

WEB

- Electrical Safe Work Practices - http://www.aps.anl.gov/About/Committees/Electrical_Safety_Committee/ElectricalSafeWorkPractices.htm

VIDEO

- Hometime Video Collection (Hometime Video Publishing Inc.) - How-To Guide to Plumbing and Electrical

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Specific Curriculum Outcomes

Students will be expected to

5.4.3 discuss safe practices when working with electricity and an electrical service [2.401][2.402][2.405][3.401][5.402]

Suggested Learning and Teaching Strategies

The general rules of safety for electricity established in previous courses of the Skilled Trades Program still apply in this instance. Special reference to them should be made at all times.

In this instance specific reference to the electrical service component is the main goal. The service is made up of a number of key components. Each of these should have been discussed in some detail in SCO 5.4.1.

These include but are not limited to:

- Main hot bus
- Neutral bus bar
- Ground Wire
- Main Power switch
- Breakers
- GFI Breakers

Extensive notes can be found in Appendix A notes section under SCO 5.4.1.

Students working with electrical circuits must be made fully aware of the dangers of working with electrical energy.

- Students must never energize a circuit that has not be inspected and approved by the instructor.
- Students must use only materials that are designed for a designated purpose. (eg. 14/2 AWG solid wire would not be appropriate for wiring baseboard heaters).
- Electrical test equipment must never be used until proper training on it application and use have be completed
- Students must be encouraged to plan out circuits and have them approved by the instructor wired before attempting to construct the circuit.

Student Activity:

Students define all of the terms associated with the key components of a main breaker box service.

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Suggestions for Assessment

Research/Presentation

- Students develop a list of proper electrical safety in the skilled trades area. This list can mirror the one found in the *Skilled Trades 1201 Curriculum Guide* and could be put into a poster or presented to the class. It should include but is not limited to:
  - make sure the circuit is not energized before working on it;
  - use tools only for the task intended, and in the manner intended;
  - follow proper protocols for handling conductors, stripping insulation, and attaching them to devices;
  - ensure all devices are attached to ground as specified; and
  - treat all electrical devices as "hot" or energized until verification that they are not attached to any power source.

Safety Test/Practical Activity

- Students should complete a safety test on the use of tools and equipment in this section of the course. This test should include rules dealing specifically with safe use of electrical circuits.

Resources

TEXT

- *Skilled Trades 1201 Curriculum Guide*
- *Smart Guide To Wiring* pg. 4
- *Modern Carpentry* - Chapter 26
- *Carpentry & Building Construction* - Unit 8, Chapter 39

WEB

- Electrical Safe Work Practices - http://www.aps.anl.gov/About/Committees/Electrical_Safety_Committee/ElectricalSafeWorkPractices.htm

VIDEO

- Hometime Video Collection (Hometime Video Publishing Inc.) - How-To Guide to Plumbing and Electrical

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Specific Curriculum Outcomes

Students will be expected to

5.4.4 review the building code requirements for placement of an electrical service and panel [1.405]

Suggested Learning and Teaching Strategies

The installation of the service panel should be completed prior to the commencement of work at this station. Students will then plan and install the necessary hardware to run branch circuits to service. There are certain aspects of the electrical service panel location that should be discussed within the group.

- Electrical panels need to be mounted on an outside wall, so that the service mast can be accessed.
- The distance from the nearest pole usually determines the location of the mast and will ultimately determine the location of the service panel
- Electrical panels need to be mounted off of the outside wall, usually on a sheet of plywood.
- Electrical panels have to be a certain distance away from water-based devices, such as sinks or water heaters. This reasoning is obvious given the incompatibility between water and electricity
- There are a variety of other regulations that can be found in the National Electrical Code. These may change according to the jurisdiction the structure is constructed in.

One of the important rules to be followed when working on a service panel is to insure that it is locked out, that is no power is moving through the panel. This is also true of work within the fabrication lab. No electrical panel that students are working on should be connected directly into the schools power system. These circuits should only be tested by using an isolated power supply or a circuit tester.

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Suggestions for Assessment

Research/Assignment

- Students identify each of the provincial and Canadian electrical regulating bodies and how they interact with the electrical code sections of the National Building Code.
- Students briefly describe the function of each regulating body.

Paper and pencil

- Students identify the basic codes that regulate branch circuits in a residence and wiring to and of electrical panels in a residence.

Resources

TEXT

- *Skilled Trades 1201 Curriculum Guide*
- *Smart Guide To Wiring*
- *Modern Carpentry* - Chapter 26
- *Carpentry & Building Construction* - Unit 8, Chapter 39

WEB

- Electrical online - http://www.electrical-online.com/electricalcode.htm
- Newfoundland Act - http://www.assembly.nl.ca/legislation/sr/annualregs/1996/Nr969120.htm
- About Building in Canada - http://www.about-building-in-canada.com/provincial.html

VIDEO

- Hometime Video Collection (Hometime Video Publishing Inc.) - How-To Guide to Plumbing and Electrical

NOTES

- Appendix A - Notes Section

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Specific Curriculum Outcomes

Students will be expected to

5.4.5 install breakers within a standard service panel [1.405, 2.401, 2.404]

Suggested Learning and Teaching Strategies

In this instance, the installation of breakers is the most important step within the process of setting up a panel. Essentially, the installation of a circuit requires a breaker or series of breakers. The theory is that a full examination of what electrical load will be on the circuit will determine the size of the breaker in question.

The use of Ohm's law

$$P = VI$$

will determine the wattage of each individual section of the circuit. Power usage is cumulative, with each section adding to the total. An example is:
A 15 amp breaker is to be installed. An analysis of the circuit shows that there are three lights, each with a 120 watt power use, and two receptacles. The receptacles include one used for a computer, with a 450 watt power supply and a 250 watt monitor. Normal household circuits carry 110 volts from their service.

Total wattage used on the circuit = 960 watts
Restriction from the breaker = 1650 watts
Total wattage leftover = 690 watts

This would be the restriction on what could be used in the other receptacle without tripping the breaker. Please note, that circuits are usually grouped by type and location within a residence. That is lights are usually grouped with lights within a certain section of a house, and put on a single or a brace or breakers. Receptacles are usually grouped as well, with some estimation of what will be used on each circuit. This can be done because as each area of the house uses different standard electrical appliances.

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Suggestions for Assessment

Practical Activity

- Students use electrical plans or floor plans created in other activities as a reference, to complete the following task for the electrical systems installation of the major project:
  - install single breakers
  - install double breakers
  - test installation

Work log

- Students create an appropriate entry in the work log outlining the skills they have used.

Research/Practical Activity

- Students calculate the maximum number of household lights, receptacles, switches and appliances can be hooked into a 15 Amp residential circuit and a 20 Amp residential circuit.

- As an extension, students compare the watt production of the wind turbine and solar cell to a normal household circuit to determine how many devices the two of them, together, could power.

Resources

TEXT

- *Smart Guide To Wiring*
- *Modern Carpentry* - Chapter 26
- *Carpentry & Building Construction* - Unit 8, Chapter 39

WEB

- Electrical online - http://www.electrical-online.com/replacingabreakerinyourpanel.htm
- About.com - http://electrical.about.com/od/panelsdistribution/ss/wireelectpanel.htm
- Ask the builder - http://www.askthebuilder.com/B320_Installing_Circuit_Breakers.shtml

VIDEO

- Hometime Video Collection (Hometime Video Publishing Inc.) - How-To Guide to Plumbing and Electrical

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Specific Curriculum Outcomes

Students will be expected to

5.4.6 tie a branch circuit into an electrical panel [2.401, 2.404]

Suggested Learning and Teaching Strategies

The branch circuit is the one which will be used to bring an alternative energy solution into a household service. There are many regulations dealing with this area within the National Building Code and provincial regulatory bodies. A study of these should be undertaken by the students in this section. From the point of view of this activity though the following is important to note:

- Alternative energy production devices should be either the main supplier of energy for the service panel or should have a separate panel of their own within a household service.
- No one can generate electricity and distribute it other than Newfoundland and Labrador Hydro. This means that an alternative energy solution will have to be distinctly separated from the main distribution network.
- Alternative energy production devices are not continuous and require a source for charging so that energy is consistent. Battery banks are the storage solution of choice, and these devices must be converted to household AC current.
- Battery banks must be continuously charge and periodically discharged and conditioned so that they have maximum power storage ability.

The panel in this case will be tied into the battery bank rather than directly into the panel.

It is expected that this section will include testing circuits using one of the available meters. This does not necessitate the hooking up of the panel into a regular service, but running some sort of low power levels than can be measured at different sections of the circuit.

Voltage across the breaker, across the service and output, across the out wire and in wire will indicate the continuity of the wiring job. This process includes:

- a visual inspection,
- a review of the circuit diagram and
- a series of tests across common testing points.

Topic 4 – Service Panel Wiring for Off-the-grid technologies

Suggestions for Assessment

Practical Activity

- Students use electrical plans or floor plans created in other activities as a reference, to complete the following task for the electrical systems installation of the major project:
  - mark out placement of the panel on the structure
    - include the alternate energy branch circuit
  - drill holes for wires to enter the panel box
  - install tie in of alternate energy production materials

Work log

- Students create an appropriate entry in the work log outlining the skills they have used.

Practical Activity

- As an extension to the calculations suggested in the pervious outcome, students compare the watt production of the wind turbine and solar cell to a normal household circuit to determine how many devices the two of them, together, could power.

Resources

TEXT

- *Smart Guide To Wiring*
- *Modern Carpentry* - Chapter 26
- *Carpentry & Building Construction* - Unit 8, Chapter 39

WEB

- Electrical online - http://www.electrical-online.com/
- About.com - http://electrical.about.com/od/panelsdistribution/ss/wireelectpanel.htm
- Ask the builder - http://www.askthebuilder.com/

VIDEO

- Hometime Video Collection (Hometime Video Publishing Inc.) - How-To Guide to Plumbing and Electrical

Topic 5 – Hydrogen Fuel Cells

Specific Curriculum Outcomes

Students will be expected to

5.5.1 trace the historical development of hydrogen as a fuel source [1.405]

Suggested Learning and Teaching Strategies

This section is an overview of the research that lead to the development of the hydrogen fuel cell. Hydrogen, since its discovery, has been seen as a possible fuel source and been used as one in some instances.

Beyond the history of hydrogen and the fuel cell, some of the focus should be on the use hydrogren has had outside this one area. Hydrogren and other combustible gases have been used in a variety of ways to initiatie energy. In the case of Newfoundland and Labrador, Hydrogen is used in concert with wind turbines as a methodology for providing power. A pilot project on Ramea uses wind energy to produce hydrogen which is then stored and burned cleanly in a hydrogen generator assembly.

Although the notes section concentrates on the fuel cell development, other types of hydrogen fuel use are documented, and some are still viable today. When examining fuel cells and other uses of hydrogen as a fuel source, students shoule be encouraged to seek out answers of why the fuel cell is so popular, and why some of the other methods developed are not.

Student Activity:

Students discuss, in the whole class or in small groups, some of the recent developments in fuel cells and what it could mean to the whole alternative energy debate.

Topic 5 – Hydrogen Fuel Cells

Suggestions for Assessment

Paper and pencil/Research

- Students develop a timeline from research they have done in this area. This section can be done as an individual research section, with students working independently.

Research/Assignment

- Students research the other uses that hydrogen has been put to since its discovery and how this may or may not have influenced its development as an energy source. This could be placed in their content portfolio or noted for their design portfolio.

Resources

TEXT

- *Heathkit Teacher Guide*
- *Heathkit Student Manual*
- *The Solar Hydrogen Civilization*

WEB

- Princeton Fuel Cell History - http://www.princeton.edu/~chm333/2002/spring/FuelCells/fuel_cells-history.shtml
- Smithsonian Institute - http://americanhistory.si.edu/fuelcells/
- Corrosion Doctors - http://corrosion-doctors.org/FuelCell/History.htm

VIDEO

- Heathkit Alternative Energy Video

NOTES

- Appendix A - Notes Section

Topic 5 – Hydrogen Fuel Cells

Specific Curriculum Outcomes

Students will be expected to

5.5.2 review and demonstrate proper safety procedures when working with hydrogen fuel cell technology [1.405]

Suggested Learning and Teaching Strategies

General shop safety rules are in place any time a student is working in the fabrication room. These should be reviewed with students at the beginning of the modular section. Specifically, hydrogen gas is a highly flammable substance that must be treated with respect.

- Within the shop environment it is possible to electrolyze hydrogen gas for immediate experimental purposes. This is done using a small direct current (DC) power source (no more than 3 Volts). In no manner should this be done with an AC current.
- Any experiment utilizing water and electricity must be carried out using the specific instructions provided. Such an experiment must be kept well clear of any alternating current (AC) electrical sources at all times.
- When working in the lab students must wear safety glasses at all time

Outside the fabrication room, the use of hydrogen gas for any sort of personal use is strictly forbidden. Hydrogen has a high degree of flammability, and the processes used to create it are quite simple. Teachers should insure that students leave any activity involving hydrogen with a healthy respect of the dangers.

5.5.3 explain how a fuel cell can produce electricity [1.405]

When introducing this concept teachers are reminded not to get too lost in theory of how it works. As simplistic and interesting an explanation as possible is suggested. A fuel cell is a storage device...it can be likened to a rechargeable battery. A battery, like a fuel cell, uses chemicals and chemical reactions to produce an electrochemical reaction. That is where the electricity comes from. The difference is that a fuel cell usually has a steady stream of chemicals to draw on, and that the two chemicals used are oxygen and hydrogen. Students should see that having two such friendly chemicals that produce a by-product of water as part of the process is part of the “charm” of the fuel cell.

Topic 5 – Hydrogen Fuel Cells

Suggestions for Assessment

Research/Presentation

- Students search a hydrogen manufacturers site for examples of safety procedures used in their production facilities. A search of manufacturers and their websites may lead to information about this.
- Students research common safe work sites, dealing with flammable gases, as well as their own fabrication lab safe tool use for machinery that has common features with gas production (such as a compressor), and try to come up with a list of safe work rules dealing with fuel cell technology. This could be presented to the class.
- Students review an MSDS sheet for hydrogen gas and outline the inherent dangers in a poster or presentation.

Research/Presentation

- Students create a presentation, a self-directed learning module or poster to explain how a hydrogen fuel cell works. They should put it in their own words and describe it in such a fashion that a grade 5 or 6 student could understand it.

Resources

TEXT

- *Heathkit Teacher Guide*
- *Heathkit Student Manual*
- *The Solar Hydrogen Civilization*

WEB

- Safe fuel cell use - http://www.standardslearn.org/documents/FuelCellStandards.pdf
- Fuel cells in cars - http://ezinearticles.com/?How-Safe-Are-HHO-Fuel-Cells-For-Cars?&id=1222904

VIDEO

- Heathkit Alternative Energy Video

WEB

- How Stuff Works - http://auto.howstuffworks.com/fuel-efficiency/alternative-fuels/fuel-cell.htm
- Energy Independence - http://www.energyindependencenow.org/pdf/fs/EIN-HowFuelCellWorks.pdf

NOTES

- Appendix A - Notes Section pg. 16

Topic 5 – Hydrogen Fuel Cells

Specific Curriculum Outcomes

Students will be expected to

5.5.4 differentiate between the types of fuel cell and their applications [1.405]

Suggested Learning and Teaching Strategies

The basics of this outcome are to introduce the fact that "fuel cell" is not a single entity but rather a series of cells that do the same thing for different purposes.

The types of fuel cells are classified by the types of electrolyte used and their operating temperature.

Types of Fuel Cells:
- Polymer Exchange Membrane Fuel Cells
- Solid Oxide Fuel Cells
- Alkaline Fuel Cells
- Molten-Carbonate Fuel Cell
- Phosphoric-Acid Fuel Cells
- Direct Methanol Fuel Cell

Introducing this topic after some student research into these areas may be enhanced by having a class discussion. In that instance each type could be discussed with students suggesting what uses may be appropriate.

Student Activity:

Students should be made aware of the different types and how they can be used for different purposes. Although this lends itself to direct instruction, a series of research projects in small groups could also be used here. In that instance, independent learning projects would be used as a method of garnering the information and then be followed up with presentations to pass that information on to the rest of the class.

Topic 5 – Hydrogen Fuel Cells

Suggestions for Assessment

Research/Assignment

- Students create a chart of the different types of fuel cells and their basic uses, whether industrial or commercial. This could be done as a poster.
- Students draw a diagram explaining one of the fuel cell types in detail and how it works. This should be done in such a way that a younger student could understand.

Resources

TEXT

- *Heathkit Teacher Guide*
- *Heathkit Student Manual*
- *The Solar Hydrogen Civilization*

WEB

- How Stuff Works - http://auto.howstuffworks.com/fuel-efficiency/alternative-fuels/fuel-cell.htm
- Energy Independence - http://www.energyindependencenow.org/pdf/fs/EIN-HowFuelCellWorks.pdf

VIDEO

- Heathkit Alternative Energy Video

NOTES

- Appendix A - Notes Section

Topic 5 – Hydrogen Fuel Cells

Specific Curriculum Outcomes

Students will be expected to

5.5.5 discuss barriers to mainstream use of fuel cell technology [1.401, 1.404, 1.405, 2.404]

Suggested Learning and Teaching Strategies

Before fuel cells can be adapted as a viable source of energy there are a number of problems that must be addressed.

The barriers are consistent with those for other non-fossil fuel based transportation systems. The main contender for fuel cell use in transportation is the polymer exchange membrane fuel cell (PEMFC) described in the last outcome. Below is an outline of the barriers involved:

- Cost - The components used to produce a PEMFC that can be used in transportation are made from expensive materials.
- Durability - Due to the start and stop cycles of a transportation vehicle the membrane becomes contaminated and looses it efficiency.
- Hydration - The membrane must be hydrated in order to produce electricity in subzero weather.
- Delivery - Compressor technology is not suitable for use in vehicle application.
- Infrastructure - Currently there is no infrastructure in place to produce large scale amounts of hydrogen and no system to deliver to the place of usage.

Student Activity:

For each of the barriers presented, in small groups or a full class discussion, students should develop some responses to the barriers. It is not enough for students to suggest that technology will fix the problem in each case, although that is a legitimate claim, but rather what could happen with existing technology.

Topic 5 – Hydrogen Fuel Cells

Suggestions for Assessment

Research/Assignment

- Students research the reasons why there has not been wide-spread use of fuel cell technology in transportation and what has to happen for it to be possible. This can be passed in as an assignment or added to a course portfolio.

Research/Presentation

- Students develop a short-term plan for what has to be done to make fuel cells a reality for at least mass transportation or public transit. This could be presented to the class as whole and used in a small group or class discussion.

Resources

TEXT

- *Heathkit Teacher Guide*
- *Heathkit Student Manual*
- *The Solar Hydrogen Civilization*

WEB

- Barriers to use of fuel cell technology - http://www.rise.org.au/info/Tech/fuelcells/index.html
- Advantages and disadvantages of fuel cell technology - http://www.fuelcelltoday.com/media/pdf/education-kit/Advantage-Disadvantages.pdf

VIDEO

- Heathkit Alternative Energy Video

Topic 5 – Hydrogen Fuel Cells

Specific Curriculum Outcomes

Students will be expected to

5.5.6 demonstrate the use of a hydrogen fuel cell device {1.405, 2.401, 2.404]

Suggested Learning and Teaching Strategies

There are two projects planned for this outcome. Working with a stand-alone fuel cell, and a model fuel cell car kit. The standalone fuel cell allows students to experiment with a fuel cell, working with electrolysis equipment and an experimental station. Students can produce hydrogen, transport to a fuel cell and measure the results. The model fuel cell car kit also produces hydrogen from electrolysis, but in this case demonstrates a direct motive application for the technology.

Points to emphasize

- Electrolysis is a process of separating bonded elements and compounds by passing electricity through them.
- The fuel cell actually works by reversing the electrolysis process
- Salt is added to the water to increase its salinity and in turn increase its conductivity
- Important to emphasize that the fuel cell works without a power source connected all the time. It is “charged” by power but will produce electricity independently.

Student Activity:

- Students research the amount of salt necessary to achieve a good return in the electrolysis process.
- Students experiment with the model fuel cell car kit, determining what its maximum ability is to store hydrogen.

Topic 5 – Hydrogen Fuel Cells

Suggestions for Assessment

Practical Activity

- Students, using the bench-top fuel cell trainer, test and experiment with a fuel cell. An assignment or series of log entries on this material would be suggested.

Research/presentation

- Students research material on fuel cells, and determine how large one would have to be to power a city bus. They can use the range of size for their own fuel cells and scale it up to move something much larger.

Research/Practical Activity

- Students could, using the fuel cell car, determine how much charging is required for how much motion of the car. As well they can research other methods of renewing a fuel cell rather than through the advent of producing hydrogen with an electric current.

Resources

TEXT

- *Heathkit Teacher Guide*
- *Heathkit Student Manual*
- *The Solar Hydrogen Civilization*

WEB

- How hydrogen cells work - http://auto.howstuffworks.com/fuel-efficiency/alternative-fuels/fuel-cell.htm
- Hydrogen fuel cell car video - http://www.alternative-energy-news.info/technology/fuel-cells/

VIDEO

- Heathkit Alternative Energy Video

MATERIALS

- HeathKit Fuel Cell car project pack
- HeathKit Fuel Cell project pack

Topic 5 – Hydrogen Fuel Cells

Specific Curriculum Outcomes

Students will be expected to

5.5.7 identify a series of machines that can be powered by fuel cell technology {1.401, 1.405]

Suggested Learning and Teaching Strategies

Much of the available literature promotes hydrogen as a source of energy which can be utilized in most internal/ external combustion engines with some minor modifications. The internet provides many examples of gasoline engines that have been converted to hydrogen fuel.

As well there are significant possibilities for use of fuel cells in power generation as well in the production of motive power.

In this section we have been looking at hydrogen fuel cells rather than hydrogen as a fuel used directly. There are a myriad of possibilities in this area for many power generation and motive power applications. One of the areas that students need to understand is that there are many more ways to get hydrogen, rather than simple electrolysis. A list is included below

1. Steam on heated carbon
2. Decomposition of certain hydrocarbons with heat
3. Reaction of sodium or potassium hydroxide on aluminum.
4. Electrolysis of water
5. Displacement of acids by certain medals

In the wind generation section, students will be looking at using hydrogen gas as a fuel source directly.

Topic 5 – Hydrogen Fuel Cells

Suggestions for Assessment

Research/Presentation

- Students research a number of transportation or mechanical devices that could run on fuel cells.

- Students research the variety of devices that can use hydrogen gas directly as a power source. This could then be compared to the list of those using fuel cells.

Research/Guest Speaker

- Students research the production of hydrogen gas at the pilot wind generating station on Ramea. This station uses wind energy to produce electricity that produces hydrogen which then is stored and burned in a hydrogen burning generator. A representative from Nalcor could be invited to the class as a guest speaker.

Resources

TEXT

- *Heathkit Teacher Guide*
- *Heathkit Student Manual*
- *The Solar Hydrogen Civilization*

WEB

- Vehicles that can be powered by hydrogen - http://en.wikipedia.org/wiki/Hydrogen_vehicle
- Hybrid Technology - http://auto.howstuffworks.com/fuel-efficiency/hybrid-technology/hydrogen-cars.htm/printable
- Ballard Fuel Cell research - www.ballard.com

VIDEO

- Heathkit Alternative Energy Video

Topic 6 – Heat Pump Technology

Specific Curriculum Outcomes

Students will be expected to

5.6.1 review and demonstrate proper safety procedures when working with a heat pump system [1.405]

Suggested Learning and Teaching Strategies

There are many considerations when using a heat pump. Some of them are specific to safety, but others are more specific to operational efficiency. Both are included here for completeness.

Points to emphasize

- Keep the temperature set point consistent. A standard heat pump thermostat has two controls, one for the heat pump and one for the supplemental heat. If the temperature difference between the room and thermostat set point is more than -17° C or -16° C (2° or 3° F), the supplemental heat will be activated.
- Manually adjusting the thermostat will result in greater reliance on the supplemental heaters and will reduce the efficiency of the heat pump system and increase operating costs.
- Replace filters regularly. Vacuum dirt and dust from the indoor coil once a year to prevent restricted airflow. Adequate air flow through a heat pump system is critical to ensure efficient and comfortable operation.
- Keep supply vents open and free from obstruction. Closing off supply vents will restrict air flow and reduce system efficiency as well as reduce the life of the compressor.
- Keep the coil in the outdoor unit clear of snow, leaves and other debris so that air flow is not restricted.
- In belt-driven indoor units, check this tension in belt once a year and adjust if loose
- Be extra careful around water
- Don’t form a natural circuit. For example, don’t touch a metal object (especially a faucet) as you unplug or plug in an appliance.
- Don’t play electrician. What seems like a simple wiring project can easily turn deadly. Leave electrical wiring projects to the professionals.

Topic 6 – Heat Pump Technology

Suggestions for Assessment

Research/Presentation

- Students do and internet search for examples of safety procedures used in heat pump installation and use.
- Students research common safe work sites, dealing with heat pumps, as well as their own fabrication lab safe tool use for machinery that has common features with heat pumps, and try to come up with a list of safe work rules dealing with windmill technology. This could be presented to the class as a whole.
- Students review the safety precautions in place when working with water and electricity and extrapolate their use in this area. A poster for safe heat pump technology use could be created.

Resources

WEB

- How to install a heat pump - http://www.howtodothings.com/home-and-garden/a3778-how-to-choose-and-install-a-heat-pump.html
- Good practice guide to heat pump installation - http://www.energywise.govt.nz/node/7801
- Heat pump installation - http://www.buzzle.com/articles/heat-pump-installation.html
- http://thegreenblue.co.uk/practicalprojects/documents/CaseStudy12HeatPumpsBW.pdf

Topic 6 – Heat Pump Technology

Specific Curriculum Outcomes

Students will be expected to

5.6.1 Review and demonstrate proper safety procedures when working with a heat pump system [1.405]

(cont'd)

5.6.2 outline the historical use and development of heat pump technology [1.401, 1.405]

Suggested Learning and Teaching Strategies

With heat pump technology, some aspects require the ducting to be buried. The following are considerations before moving into the digging phase:

- Call before digging. Contact any service companies (electrical, natural gas, etc.) to ensure there are no obstructions ie: gas pipes.
- Know where electrical equipment is at all times. Look around and look up to ensure a safe distance from wires.
- Have a professional electrician check the main breaker panel to determine what your electrical supply is and to see if there are any alterations or additions required to be completed.

Student Activity:

- Students differentiate between those rules meant for safe operation and those meant for efficient operation.
- Students also develop a series of rules for the specific use of the heat pump in the fabrication lab environment.

The heat pump history can be traced to two distinct scientific histories as a result of the two types of heat pumps, air source and ground source. The air source heat pump was theorized by Lord Kelvin, as outlined in the notes section. The ground source heat pumps derive some of their popularity from geothermal energy. The theory behind geothermal energy finds roots in ancient times through the use of hot springs and similar natural features. It is the capability and efficiency of the ground-source type of heat pump that has created the interest in this alternate source of heating. Even in Newfoundland and Labrador, new green buildings are deriving upwards of 90% of their heat energy from ground source heat pumps. New schools, swimming pools and hockey rinks will use the technology to recover

Topic 6 – Heat Pump Technology

Suggestions for Assessment

Research/Presentation

- Students research some of the reasons why heat pumps were used and how they have developed into a major alternative heating solution.

Discussion

- Students discuss, in small groups or as a class, how some of the historical uses for heat pumps may still have applicability today.

Resources

WEB

- History - http://www.bookrags.com/research/heat-pump-woi/
- History of geothermal energy - http://www.top-alternative-energy-sources.com/history-of-geothermal-energy.html
- About heat pumps - http://www.igshpa.okstate.edu/about/about_us.htm
- An example of a heat pump - http://www.cedarwoodheating.com/webapp/GetPage?pid=253
- Wiki on Heat pump http://en.wikipedia.org/wiki/Heat_pump

Topic 6 – Heat Pump Technology

Specific Curriculum Outcomes

Students will be expected to

5.6.2 outline the historical use and development of heat pump technology [1.401, 1.405]

(cont'd)

5.6.3 differentiate between the different types of heat pump installations [1.401, 1.405, 2.401]

Suggested Learning and Teaching Strategies

waster heat as well.

This is one area where new buildings in the province are using the technology in greater numbers. The possibility for linking with these new constructs and see the technology either while being installed or in action should not be passed over.

Student Activity:

Through an interactive discussion, the teacher should overview the historical evolution of the heat pump. Along with the historical discussion questions such as what is a heat pump, how a heat pump works, and some terminology should be answered.

There are two different methods used in the technology of heat pumps. One involves gaining heat from the earth, or ground source heat pump technology; and one involves getting heat from the air, or air source heat pump technology. Some explanation of what the general physical characteristics are of each of the two types is necessary to understand the technology further.

Ground source heat pumps
The earth is a huge heat sink (an environment or object that absorbs and dissipates heat from another object.)
Through a system of underground or under water liquid filled pipes and a heat exchanger that is located within the building, a ground-source heat pump extracts heat from the earth or ground water to use to heat your home, business, etc. It can work in reverse and be used for cooling when

Topic 6 – Heat Pump Technology

Suggestions for Assessment

Research/Assignment

- Students research heat pumps currently in use in industrial and residential areas within the province.

Research/Assignment

- Students create a chart of the different types of heat pumps and their basic uses, whether industrial or commercial. This could be done as a poster.

- Students draw a diagram explaining one of the heat pump types in detail and how it works. This should be done in such a way that a younger student could understand.

Resources

- United Association of Plumbers, Pipefitters and Steamfitters training centre - http://www.ualocal740.ca/3drendering.aspx
- City of Mount Pearl - http://www.mountpearl.ca/ckfinder/userfiles/files/recreation/Media%20Release%20-%20May%2019%20-%20Green%20Fund%20Cheque%20Presentation.pdf

NOTES

- Appendix A - Notes Section pg. 17

WEB

- Ground Source Heat Pump - http://www.greenspec.co.uk/documents/energy/GSHP1.pdf
- Space Heating - http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12650
- Heat Pumps - http://oee.nrcan.gc.ca/publications/infosource/pub/home/heating-heat-pump/booklet.pdf

Topic 6 – Heat Pump Technology

Specific Curriculum Outcomes

Students will be expected to

5.6.3 differentiate between the different types of heat pump installations [1.401, 1.405, 2.401]

(con'td)

5.6.4 describe the common usages for heat pump technology in Newfoundland and Labrador [1.401, 1.405]

Suggested Learning and Teaching Strategies

it is too warm. Earth-energy systems (EES's) can be used with forced-air (water to air) and hydronic (water to water) heating systems. The system can be either and closed loop or open loop system.

Air source heat pumps

These systems draw heat from the outside air during cooler times and extract heat to the air during warm times. Through this we are able to heat and cool our homes.

There are two types of air-source heat pumps, air to air and air to water.

Student Activity::

Students create diagrams to illustrate the two forms of heat pumps and the variations of each of these. Diagrams are labeled and indicate how the systems actually work.

Through a class discussion/demonstration it should be shown that heat pumps are not new and are in use around us every day. They are mainly used for cooling but used in reverse they offer heat as well.

There should be an explanation/demonstration of how heat is extracted from one place and released elsewhere.

Common usages of heat pumps:

Refrigerators

Freezers

Air Conditioning units

Geothermal heat pumps

Air source heat pumps

Topic 6 – Heat Pump Technology

Suggestions for Assessment

Research/Presentation

- Students research the common uses for heat pumps in industrial and residential areas and extrapolate from that how heat pumps could be used in Newfoundland and Labrador.

- As an extension, students research what types of heat pump technologies are actually in use in the province and how that differs from the list developed above. This result in a presentation to the class or as a group for whole class discussion.

Resources

NOTES

- Appendix A notes section

WEB

- Basics of heat pump use - http://www.house-energy.com/Heat-Pumps/Basics-Heat-Pumps.htm

Topic 7 – Sustainable Housing

Specific Curriculum Outcomes

Students will be expected to

5.7.1 describe what is entailed within the concept of sustainable housing [1.401, 1.405]

Delineation

Concepts to emphasize

- R-2000
- Air flow
- Insulative values

Suggested Learning and Teaching Strategies

There are a variety of things that people can do to reduce their impact on the environment and their energy use overall in their homes. The use of energy-efficient appliances, turning down thermostats, programmable thermostats, using compact fluorescent bulbs, the installation of a heat pump or other alternative energy device all can add to the savings realized within a household. Along with all of these measures comes the concept of sustainable housing.

Sustainable housing refers to that aspect of residential construction dealing with air flow and insulation. It is about reducing air-leakage and increasing the standards of insulation within a house. A test of a house from a sustainable housing perspective will not only involve determining location and amount of insulation in walls, ceilings, exposed areas but the use of air/vapour barriers in those areas. A blower-door device, allowing for a lessening of air pressure in the house, is used to map and quantify air-leakage within the residence. With this information, a model of how the house "breathes" and retains heat is able to be created, allowing for quantification of changes and the benefits that could be realized.

National Resources Canada has specified a series of requirements that will make a house perform at an excellent rate for energy efficiency, indoor air quality and the use of environmentally responsible products and materials. These requirements form the basis of the R-2000 standard. It does not in any way dictate how the house must be built or what it looks like, only how it should perform. Everything from protecting air quality by using water based paints and green carpets, to insuring that all floors, walls and ceilings are properly insulated is covered.

Topic 7 – Sustainable Housing

Suggestions for Assessment

Research/Presentation

- Students take one of the precepts of sustainable housing and do a presentation to the class as to what it entails. This could include but is not limited to:
  - R-2000
  - Air flow
  - Insulative values
  - Blower door

Research Assignment

- Students identify the trades involved in creating a sustainable house or an R-2000 designation. In determining the trade, students also research the level of work that has to be done to create a structure with that designation.

Resources

TEXT

- *Modern Carpentry* - Unit 14

WEB

- Study on sustainable housing - ftp://ftp.cmhc-schl.gc.ca/chic-ccdh/Research_Reports-Rapports_de_recherche/eng_unilingual/LifeCycle_WEB.pdf
- Home energy evaluation - http://www.sustainablehousing.ca/ and http://www.cmhc.ca/en/inpr/su/eqho/

Topic 7 – Sustainable Housing

Specific Curriculum Outcomes

Students will be expected to

5.7.2 define R-value in terms of energy loss over square footage of a material [1.405, 3.401, 3.402]

Delineation
- R-value
- U-value
- Methods of heat transfer
  - Conduction
  - Convection
  - Radiation

5.7.3 differentiate between different insulation types and their appropriate use in residential construction/renovation. [1.401, 1.405, 2.404]

Delineation
- R-value
- Batt or blanket insulation
- Loose-fill insulation
- Rigid board insulation
- Spray-foam insulation
- Radiant Barrier Insulation

Suggested Learning and Teaching Strategies

When engaged in a conversation about insulation and sustainable housing, the term R-value will be used extensively. Most people understand that the higher the R-value the better the insulative value of the material being used. For the designer or installer understanding what R-value pertains to will aid in insuring the right insulation for the right job.

R-value is defined as a commercial unit used to measure the effectiveness of thermal insulation. Further background and explanation material is found in the notes section.

Students should be familiar with where the the r-value comes from in a practical sense as well as a theoretical one. Understanding what the r-value might mean for energy savings is as important, if not more, than recognizing where the value came from.

There are a variety of insulation types available for the consumer. In many cases the type lends itself to the situation in which it will be used.

- Batt or blanket insulation- This is the most common type and most commonly used in exposed wall spaces and attics, and is usually installed early in the construction process once walls have been formed. Although easily cut and shaped as necessary, its large size necessitates large exposed areas for installation.
- Loose-fill insulation - Loose-fill can be installed in either enclosed cavities, such as walls, or unenclosed spaces, such as attics. Most often loose-fill insulation is blown in
- Rigid board insulation- This type of insulation is made to be used in confined spaces like basements, foundations, crawl spaces, and exterior walls. The rigid boards are permanently fastened to the surface and as

Topic 7 – Sustainable Housing

Suggestions for Assessment

Research/Assignment

- Students research the origin of R-value and how it has become synonymous with insulation in the residential world.
- Students research the various methods of heat transfer and how they are integral to the theory behind the use of insulation.

Practical Activity

- Students calculate what the actual heat loss is through a common value of insulation. This could be done as an assignment of a whole class activity.

Research/Assignment

- Students create a chart of the different types of insulation, their basic uses, whether industrial or commercial and the proper situation for its deployment.
- Students draw a diagram explaining one of the insulation types in detail and how it works. This should be done in such a way that a younger student could understand.

Resources

TEXT

- *Modern Carpentry* - Unit 14

WEB

- Definition of r-value - http://en.wikipedia.org/wiki/R-value_(insulation) and http://en.academic.ru/dic.nsf/enwiki/157906
- Insulating your house - http://www.cmhc-schl.gc.ca/en/co/maho/enefcosa/enefcosa_002.cfm
- About r-value - http://rvalue.net/

NOTES

- Appendix A notes section pg. 18

Topic 7 – Sustainable Housing

Specific Curriculum Outcomes

Students will be expected to

5.7.3 differentiate between different insulation types and their appropriate use in residential construction/renovation. [1.401, 1.405, 2.404]

(cont'd)

Delineation

- R-value
- Batt or blanket insulation
- Loose-fill insulation
- Rigid board insulation
- Spray-foam insulation
- Radiant Barrier Insulation

Suggested Learning and Teaching Strategies

such it is often easier and sometimes only possible to install this type during construction.

- Spray-foam insulation - Relatively new in the housing industry, but can be used in almost every situation where the others can. It is more expensive than the other types and has to be put in during construction of the structure.
- Radiant Barrier Insulation - usually an attic-based installation. Will create a barrier for heat and cold. Can replace batt installation in that regard.

Students should be clear on the situations whereby each of the insulation types can be used. One of the reasons of the popularity of batt insulation is how easy it can be installed. While blow-in insulation is the easiest to use for existing wall structures due to the lack of destruction of the wall necessary to get the insulation in. When students see the examples of the insulation in action they will be able to better understand the situational as well as cost factors involved in each.

Student Activity:

Students should have some samples of the different types of insulation in class so that they can see for themselves the differences. The insulation could be loose or in an already prepared structure showing the various types.

Topic 7 – Sustainable Housing

Suggestions for Assessment

Research/Presentation

- Students create a presentation, a self-directed learning module or poster to explain how insulation works. They should put it in their own words and describe it in such a fashion that a 10 year old could understand it.

Discussion

- Students identify the most common insulation used in residential and industrial properties in this province, and then compare that to standards in other provinces. This comparison could be handed in as a written assignment or could be used for a small group or whole class discussion.

Research/Presentation

- Students research which of the listed insulation types has the least impact on the environment. This then be compared to the popularity for its use in this province and other parts of the country.

- Students do a comparison of the different R-value associated with the different types of insulation. This could be done as a relation of volume to R-value, or as one of cost to R-value. Extending this assignment to compare the popularity of the material as discussed previously is also an option.

Resources

TEXT

- *Modern Carpentry* - Unit 14

WEB

- Choosing insulation - http://oee.nrcan.gc.ca/residential/personal/new-home-improvement/choosing/insulation-sealing/materials/khi-insulation.cfm?attr=4
- Insulation types - http://www.insulation-guide.com/insulation-types.html
- Energy savers (US) - http://www.energysavers.gov/your_home/insulation_airsealing/index.cfm/mytopic=11510
- 10 Types of insulation - http://home.howstuffworks.com/home-improvement/construction/materials/10-types-of-insulation.htm
- Types of Home Insulation - http://www.heating-and-air-conditioning-guide.com/types-of-home-insulation.html
- Types of insulation - http://www.cmhc-schl.gc.ca/en/co/maho/enefcosa/enefcosa_002.cfm

NOTES

- Appendix A notes section pg. 19

Topic 7 – Sustainable Housing

Specific Curriculum Outcomes

Students will be expected to

5.7.4 describe the function of a vapour/ air barrier in insulation use [1.401, 1.405, 2.404]

Delineation:

- Differentiate Vapor Barrier / Air Barrier
- Role of House Wrap

Suggested Learning and Teaching Strategies

Generally speaking a vapour barrier and an air barrier are two separate entities. A vapour barrier is a construction material designed to stop or retard the passage of moisture as it diffuses through the assembly of materials in a wall.
The principle function of the air barrier is to stop air from entering the building through the walls, windows, or roof, and inside air from exfiltrating through the building envelope to the outside. For our purposes we will look at the function of a vapour barrier.

- To be effective a vapour barrier must be both resistant to the flow of water vapour and be durable.
- The effectiveness of a vapour barrier material is measured in terms of its "perm-rating". The higher the perm-rating the better the barrier.
- Many materials are effective vapour barriers and they include, polyethylene, aluminum foil, some types of paint, exterior grade plywood with polyethylene being the most common.
- Vapour barriers are generally not needed in climates where the temperature remains above freezing. Such is not the case in our climate.
- The function of the vapour barrier is to provide some protection against moisture damage to the structure and the insulation. It is placed on the warm side of a wall to keep moist laden air from collecting inside the wall structure. Once condensed inside a wall the result can be rot, mildew, and mold.

Because it is virtually impossible to stop all moisture from moving this poses a unique problem for attics. Warm moist air is constantly rising and trying to enter the attic and invariably some of it will penetrate the envelope. Therefore attics but be designed with adequate ventilation so that the circulation of fresh air will quickly remove the moist air.

Topic 7 – Sustainable Housing

Suggestions for Assessment

Research/Presentation/Discussion

- Students research the various types of material used in vapour barriers in residential construction and do a comparison of effectiveness versus cost. A class discussion or presentation could follow.

- Students research the role of house wrap in air barrier and vapour barrier support in residential construction. This could be done as a presentation or a whole class discussion.

Research/Assignment

- Students research the differences between the concept of air flow restriction and vapour restriction, with specific reference to differentiating between the need for a vapour barrier and an air barrier. This could be completed as an assignment.

Resources

TEXT

- *Modern Carpentry* - Unit 14

WEB

- Purpose of vapour barrier - http://www.energybooks.com/pdf/D1142.pdf
- Purpose of vapour barrier - http://www.cssbi.ca/Eng/_pdf/House-Chapter7Final.pdf
- Vapour barriers in home construction - http://www.nrc-cnrc.gc.ca/eng/ibp/irc/cbd/building-digest-9.html
- Installing a vapour barrier - http://www.rona.ca/content/installing-vapour-barrier_framing-excavation-foundation_renovation
- Insulating your house - http://www.cmhc-schl.gc.ca/en/co/maho/enefcosa/enefcosa_002.cfm
- Difference between a vapour barrier and an air barrier - http://www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/bpn/54_e.pdf
- Roof vapour barrier - http://alcor.concordia.ca/~raojw/crd/essay/essay000223.html

Topic 7 – Sustainable Housing

Specific Curriculum Outcomes	Suggested Learning and Teaching Strategies
Students will be expected to	
5.7.5 follow safety rules and guidelines when working with various types of insulation installations [2.401] [2.402][2.405] [3.401][5.402]	The use of any insulation requires good skin, eye and breathing protection. Workers involved in the installation of insulative materials should wear good strong gloves, have their body covered by rough material to prevent irritation of the skin, and, as in all residential construction aspects, wear safety eye wear. In this instance, as the risk is based in small airborne particulates the most appropriate type of safety eye-wear is goggles type. The most serious risk to the installer in this instance is to their breathing. The same small airborne particulates that are a risk for the eye or skin are a much more pronounced risk for the lungs and air ways. A CSA approved breath mask should be used when handling any type of insulation at all times. Beyond the hazards to the individual when installing such materials, there are inherent hazards that need to be considered within the construction area. Some types of insulation are flammable and need to be covered by an approved fire-rated material and not left open to the air.
5.7.6 install a variety of insulations in different wall/roof/floor situations [1.402, 2.401, 2.404]	By far the most common and economic type of insulation is fiberglass batt insulation. It gives the homeowner the most value for their money. In wall fiberglass insulation in combination with exterior rigid board insulation and properly installed vapour barrier is R2000 compliant as such this is what we should have our students mimic. A discussion here on 2”x4” wall construction vs 2”x 6” wall construction is needed. By using 2”x6” exterior wall studs we increase the wall thickness thus allowing more insulation. What is often overlooked is that the switch from 4” to 6” studs also moves to 24” centers instead of 16” centers. Wooden studs provide what is called a “parallel heat conduction path” that is unaffected by the insulation’s R-value. In other words the studs will conduct heat from inside to the outside. By moving to 24” centers we will have a wall of the same length but you will use fewer studs and thus a better R-value.

Topic 7 – Sustainable Housing

Suggestions for Assessment

Research/Presentation

- Students search a variety of insulation manufacturers websites for examples of safety procedures used in the use of their materials. A search of other manufacturers and their websites may lead to further information and confirm that already garnered. A list of things to consider and watch out for should be formulated and completed as a poster or presented to the class as a whole.

- Students research common safe work sites, dealing with insulation, as well as their own fabrication lab safe tool use for activities that have common features with insulation installation, and try to come up with a list of safe work rules dealing with it. This could be presented to the class.

Paper and pencil

- Students could be assessed for this outcome using the one of the Rubrics found in the *Skilled Trades 1201 Curriculum Guide* Appendices.

Work log

- Students make an entry in their work log, outlining the skills and techniques they used to complete this task

Resources

TEXT

- *Modern Carpentry* - Unit 14

WEB

- Proper safety procedures when installing insulation - http://insulation.owenscorning.ca/homeowners/insulation-products/
- Safety when working with fiberglass insulation - http://www.naima.org/pages/benefits/hspp/appendix_1.html

TEXT

- *Modern Carpentry* - Unit 14

WEB

- Insulating walls, ceilings, crawl spaces, etc. - http://www.hometime.com/Howto/projects/health/hlth_3.htm
- Insulating attics. - http://www.ornl.gov/sci/roofs+walls/insulation/fact%20sheets/attic%20floors.pdf

Topic 7 – Sustainable Housing

Specific Curriculum Outcomes

Students will be expected to

5.7.6 install a variety of insulations in different wall/roof/floor situations [1.402, 2.401, 2.404]

(cont'd)

Suggested Learning and Teaching Strategies

The rigid foam insulation used on the exterior walls is generally attached with long roofing nails, screws and or washers of some sort. The seams are taped according to manufacturer's specifications and gaps larger than ¼" are filled with a closed cell expanding spray foam.
On the inside the stud bays are filled with the batt insulation. Begin at the top of the bay and work downwards towards the floor. Insulation is manufactured to the correct width to form a friction fit between the studs and will have to be cut to fit shorter or narrower openings such below windows or in corners.

Important notes

- Insulation must not be compressed or jammed into spaces as it will adversely affect R-value.
- Scraps off a batt can be used to fill the cracks around windows and doors but should not be jammed tight.
- Once complete the shoe plate should be caulked where it meets the floor and then the vapour barrier installed.

Topic 7 – Sustainable Housing

Suggestions for Assessment

Practical activity

- Students install insulation within a partition. It is suggested that the partition should be at least 1800 mm in height (6 ft), not be 1200 mm x 2400 mm (4 ft x 8 ft) and should contain an interior or exterior corner.
- It is also suggested that one side be sheathed with some material, and that smaller areas requiring cutting and fitting be used. This could be done with a vapour barrier included, and with a variety of insulative materials, showing the different methods used.
- A test of the insulated area, from at least an air barrier perspective should be made. A small fan and small string tendrils will permit for air flow to be observed. Students should be aware of the importance of proper insulation installation for the finishing portion of residential construction.

Resources

WEB (cont'd)

- Insulating your house - http://www.cmhc-schl.gc.ca/en/co/maho/enefcosa/enefcosa_002.cfm
- Install insulation - http://www.ornl.gov/sci/roofs+walls/insulation/fact%20sheets/attic%20floors.pdf
- Do it Yourself home insulation - http://www.diyhomeinsulation.com/
- How install insulation - http://www.homedepot.ca/webapp/wcs/stores/servlet/DisplayTemplate?display=eco_healthy14&langId=-15&storeId=10051

Appendix A

Background and Reference Notes

Background and Reference Notes

Unit 1

1.2.2 Identify the rights and responsibilities of the various stakeholders including the right to refuse. [5.402]

The right to refuse is defined in the act as:
Workers may refuse work that they believe is dangerous to their health or safety, or the health or safety of fellow workers;

a) until action has been taken by the employer to the worker's satisfaction;
b) until the OH&S committee or worker health and safety representative has investigated the matter and advised the worker to return-to-work; or
c) until an officer has investigated the matter and has advised the worker to return to work.

Employers have clear responsibilities with respect to safety in the workplace. This is the second important aspect of the Occupational Health and Safety process. Employers specifically are responsible to:

1) provide and maintain a workplace and the necessary equipment, systems, and tools that are safe and without risk to the health of their workers; and
2) provide the information, instruction, training, supervision, and facilities that are necessary to ensure the health, safety and welfare of their workers.

The final aspect of the Occupational Health and Safety process is workers' responsibilities. Students should be aware that with rights comes responsibilities. Workers are responsible to:

1) protect their own health and safety and that of others workers at or near the workplace;
2) to cooperate with their employers and with other workers in the workplace to protect:
a. their own health and safety;
b. the health and safety of other workers engaged in the work of the employer; and
c. the health and safety of other workers or persons not engaged in the work place of the employer but present at or near the workplace;
3) use devices and equipment provided for their protection in accordance with the instructions for use and training provided, with respect to the devices and equipment.;

4) consult and cooperate with the OH&S committee (if there is one at the workplace) or the worker responsible for health and safety at the workplace; and
5) cooperate with the person at the workplace who is exercising a duty imposed by the Act or Regulations.

1.2.3 Explain the process for the reporting of risks, workplace issues and accidents. [5.402]

The following are excerpts from the Safe Work Newfoundland and Labrador website:

"An occupational health and safety committee is an advisory group made up of representatives from management and workers. The committee provides a forum for communication between the employer and the worker to address health and safety concerns in the workplace. In an effort to reduce workplace accidents and injuries, committees identify and evaluate concerns, make recommendations for corrective action and promote health and safety in the workplace. Committees are a legislated requirement of the Occupational Health and Safety Act and Regulations. In brief, the requirements for an occupational health and safety committee are as follows:

- A workplace having 10 or more workers is required to have a committee.
- A firm that has more than one workplace (i.e. retail company with stores across the province, school board with schools across a district etc.) must have a separate committee for each location if the number of workers at each location is 10 or more.
- The committee may consist of two to 12 members.
- At least half the members shall be elected by workers.
- The other half shall be appointed by the employer.
- The committee is to have two co-chairs one representing management and the other representing the workers.
- A list of committee members shall be posted in a conspicuous place at the workplace.
- Committee meetings shall be held every three months and during work hours as part of the job.
- Minutes of meetings are to be posted in the workplace and a copy is to be forwarded to the Commission.
- The committee shall participate in workplace inspections.
- Committee members are to be trained as per legislative requirements."

"A worker health and safety representative is required in workplaces where less than 10 workers are employed. A firm that has more than one workplace (e.g., retail company with stores across the province, school board with schools across a district etc.), must have a separate worker health and safety representative for each location if the number of workers at each location is less than 10. The employer must ensure that a worker, not connected with management, is designated as the worker health and safety representative. The worker health and safety representative must be elected by other workers or appointed by the labour union if applicable. The name of this individual is to be posted in a prominent area in the workplace.

The main role of the worker health and safety representative is to monitor the health, safety and welfare of workers employed at the workplace. The worker health and safety representative is a liaison between the employer and the workers when it comes to addressing health and safety concerns at the workplace. Worker health and safety representatives identify and evaluate concerns, make recommendations for corrective actions and promote health and safety in the workplace. They also participate in workplace inspections. Worker health and safety representatives are to be trained as per legislative requirements."

Unit 2

2.1.6	show the principles of operation of a 4 stroke cycle engine [2.404]	The intake stroke opens the intake valve, lets in the gas and air and starts the piston downwards. The compression stroke starts when the piston is at the bottom and beginning to move upward, the intake valve closes and the air fuel mixture becomes compressed. When the piston reaches the top a spark ignites the fuel air mixture, which force the piston down. This is the power stroke and the power is transferred down through the piston, the connecting rod and into the crank shaft which turns due to this power. Finally the exhaust stroke begins as the piston reaches the bottom of the cylinder and the exhaust port opens. As the piston moves up it forces the exhaust gases out through that port. Once the piston is at the top, the whole cycle starts again.

Unit 3

3.2.4 compare and contrast the three most common types of ignition used on small gas engines [2.404, 3.401]

A magneto ignition, similar to one on a chain saw or lawn mower, consists of a magnet that is moved past a coil of wire to produce an electric current. It is a little electric generator, that has been changed to produce periodic bursts of high voltage instead of continuous current. There is a bar of metal surrounded by a coil of wire, called an armature, which contains an inner coil and an outer coil with 100 times more turns of wire. When the magnet is rotated past the coil a small electric current is produced, which is magnified by the outer coil creating enough voltage for the spark. An electronic switch waits for the inner coil to reach its maximum charge before it allows the voltage to jump to the outer coil and thus create the spark.

The capacitive discharge ignition uses a high voltage power supply to charge a capacitor. It is this capacitor that discharges to charge the inner coil of the device described above. The charging of the inner coil is done from the capacitor in this case rather than from the rotation of the armature. The secondary coil once again is charged when the inner one reaches its maximum. The rest of the process remains the same.

The final type of ignition system used is the battery ignition. Battery ignitions are most common on larger vehicles, rather than small engine ones. They are found in some devices though so they will be included for completeness sake. The battery ignition works much like the capacitor system described below. Voltage from the battery is fed through the primary coil, which charges to its maximum, at which point an electronic switch engages and releases the voltage to the secondary coil which with its 100 times more wiring induces the voltage to about 20 000 volts. This then is the voltage used across the spark plug.

This is how the procedures are laid out.

- Test spark plug (Method 1)
  - Confirm plug gap and set as required
  - Hook up spark plug to a spark tester
  - Pull engine over and observe the spark produced
- Test spark plug (Method 2)
  - Put bolt in lead to see if sparks to engine

  - Leave plug in lead but out of engine
- Confirm plug gap and set as required
- Check armature air gap
- Remove pull-cord assembly from the engine
- loosen the bolts on the armature assembly
- Slide the armature away from the flywheel
- Place the appropriate shim between the flywheel and the armature
- Rotate the flywheel so magnet is opposite armature and allow magnet to attract armature
- Torque armature bolts according to engine specification and remove shim
- Check for flywheel key damage
- Remove pull-cord assembly from the engine
- Attach flywheel puller to flywheel
- Remove the flywheel
- Remove the flywheel key located in slot on the end of the crankshaft.
- Examine the flywheel key for wear and/or damage
- Replace if necessary
- Reassemble ignition and engine parts
- Test engine for starting
- Check coil continuity

3.3.3 differentiate between the methods used to supply fuel in small gas engines [2.404, 3.401]

In fuel transfer there are three basic methods available to transfer the gas from the storage (tank) to the next system in the process (carburetor) . These three methods are

- Gravity feed - in this instance the gas tank is positioned above the carburetor, with a float inside to allow for exactly the right amount of gas to come out to feed the engine. Because the gas is positioned above the engine, gravity will pull it into the carburetor.
- Suction feed - in this and the next instance, the gas tank is positioned below the carburetor, and the natural suction power created by the pistons moving up and down in the cylinders moves the gas. When a piston moves down a low pressure area is created in the throat of the carburetor which then creates a difference in pressure between the tank and the carburetor. The throat is narrowed slightly to preserve the pressure difference. This difference in pressure creates a suction that moves gas from the tank into the engine (like when you suck on a pipet or hose to get water to move)
- Pressure feed - in this case the pressure is usually caused by a fuel pump, which draws gasoline from the tank and forces it into the carburetor chamber. This type of fuel feed is also known as force feed.

3.3.4	compare and contrast the three types of carburetors used in small gas engines [2.404, 3.401]	The three types of carburetors we will be looking at are: • Float Carburetor - this type has a small reservoir or float chamber of gasoline at near atmospheric pressure, ready for intake into the carburetor as needed. As the float chamber is drained of some of its gas a small float inside will let more in. • Vacuum Carburetor - in this instance there is no chamber but rather a vacuum operated piston attached to the fuel jet with a pin. When the vacuum is highest (i.e., when there is little or no air and fuel mixture present) the pin is pulled out permitting the fuel to flow and mix with the air. • Diaphragm Carburetor - this type of carburetor stills uses a chamber, but instead of a float it uses a diaphragm. The diaphragm in the chamber expands as the fuel is drawn out by equalizing pressure, and as it expands it opens a valve that lets more fuel into the chamber, this replenishing the supply.
3.3.5	discuss the differences between the two main types of governors used in small gas engines [2.404, 3.401]	Two types of governors are: Mechanical and Air Vane. A mechanical governor, sometimes called a counterbalance or flyweight, uses the force caused by the rotation within the engine (centrifugal) to measure the load. This measurement is compared to a set adjustment, usually set by a nut, and if it falls below a certain level, a spring opens the throttle and the engine's speed is increased. Air vane governors work in much the same way, but the comparison is not based on the force of the rotation but rather the air from the rotating flywheel.
3.3.6	describe how the three types of air cleaners used in small gas engines operate [1.405, 2.404, 3.401]	Three common types of air cleaner • Dry element air cleaner • Oil-foam air cleaner • Oil bath air cleaner The dry element air cleaner is attached directly to the intake and cleans the air by passing it through layers of cloth or felt that removes large dirt particles from the air. It is used in many engine applications and is the most common one used in automobiles. The oil-foam air cleaner, is essentially oil-wetted polyurethane foam, that depending on how much it is wetted will either allow good air flow or a better amount of filtering. These are common on small engines, although it is being supplanted by the dry element cleaner listed above.

The final type of cleaner is the oil bath cleaner. This cleaner uses a pool of oil and a labyrinth of coarse filter material to force air into a series of curvy paths. The air is forced to make turns that the dirt in it cannot follow due to gravity. This cleans the air effectively without passing through a special filter that may become clogged. This is not a common type used anymore. It was very popular until the 1960s and may still be found on some older engines still in use.

3.6.2 differentiate between the types of lubrication systems found on small gas engines [2.404, 3.401]

A splash lubrication system, as the name would suggest, splashes oil is up from the oil pan or oil trays in the lower part of the crankcase. Dippers on the connecting-rod bearing caps dip down into the oil pan with each crankshaft revolution to throw oil upward as drops to provide adequate lubrication to the engine mechanism.

The pressure or pump system does not rely as heavily on the mechanism of the parts to be lubricated for operation but rather on a pump system. The oil in the oil reservoir is distributed through the parts requiring lubrication by pumping it under pressure.

Unit 4

4.1.1 Understand the relationship between work and energy. [3.402, 3.403]

Work has a definite relationship with energy. To understand work we must first understand force. Force is a push or pull on an object. If the object moves then work has been done. Work is defined as the force exerted on an object multiplied by the distance the object travels while that force is exerted. From the diagram above, the force (pull) on the block, moves it a distance, so that work was done on the block to move it to the second (grey) position.

4.1.2 differentiate between kinetic and potential energy [3.402, 3.403]

Kinetic energy is known as the energy of motion, it is the energy something gets from moving, and the energy it would take to stop it. Obviously a speeding car has a significant amount of energy it can transfer to something, while a parked car does not.

Potential energy is the energy of position, or specifically the energy something gets from either its own physical properties, or its distance from the surface of the earth. Gravitational energy would be a potential energy.

4.1.3 classify the main types of energy as being either potential or kinetic [3.402, 3.403]

Types of energy -

- Radiant Energy (kinetic) - Electromagnetic energy travelling in transverse waves, including visible light.
- Stored Mechanical Energy (potential) - This is energy that is stored in an object by the application of a force; but a perfect example is a compressed spring.
- Nuclear Energy (potential) - Energy stored in the nucleus of an atom, released through a variety of processes.
- Motion (kinetic) - Purest form of Kinetic energy, energy of an object due to its motion.
- Sound (kinetic) - Sound travels in longitudinal waves of compressions and rarefactions. These alternating bands of particles have energy within them.

- Gravitational Energy (potential) - Any two bodies exert a gravitational force on each other, and this gravitational energy gets larger depending upon the size of the body and how close they are to each other.
- Thermal (kinetic) - As an object is heated, the molecules within it speed up. They are able to transfer this energy by collisions between their molecules and other object's molecules nearby.
- Electrical Energy (kinetic) - Energy caused by the flow of electrons.
- Chemical (potential) - Energy stored within the bonds of atoms and molecules.

4.2.1 describe the most common fossil and alternative fuels [2.404, 3.404]

Points to emphasize:

- Coal is a natural dark brown to black graphite like material used as a fuel, formed from organic materials.
- Petroleum Distillates is the term used to describe the variety of petroleum products that are used as fuels. They are all distilled from crude oil by a process called fractional distillation, which works due to the fact that they all have different sizes, weights and boiling temperatures. Examples are gasoline, kerosene, diesel and lubricating oil.
- Natural gas is a mixture of hydrocarbon gases that occur naturally with crude oil deposits.
- Hydrogen is a gas, usually derived from water that can be either combusted to produce energy or be used in a fuel cell to produce energy.
- Natural gas is listed in both places, because it is considered to be an alternative fuel for motive applications in buses and other forms of transportation.
- Propane is a natural gas derivative, also used as an alternative fuel for motive applications.
- Biofuel is the name given to treated waste used to produce methane, peat which is used as a combustive fuel and natural oils extracted from vegetable matter.
- Alcohol is just as the name suggests, alcohol. The most common type is ethanol which is created from fermented corn, and can be used in gasoline engines. Ethanol is considered an alternative fuel because it is renewable and burns cleaner than gasoline.

4.2.4 become aware of the Environmental Considerations involved with renewable, non-renewable and inexhaustible energy sources [2.404, 3.404]

Sustainability was introduced briefly as a topic in 3.2.2 within the student section. This section of the course will introduce it in its broadest sense. Sustainability is the ability of a process to keep going over a long period of time. Something is sustainable if it has minimal impact on its surroundings and is able to keep functioning on resources readily available. In this manner, non-renewable resources would not be considered sustainable, but renewable and inexhaustible would.

Environmental impact is the term used to describe the effect that something has on the environment. In this specific case, effects are based not only on the burning of fuels, but the production and refining of fuels. How much impact does drilling for oil, mining coal, planting corn, recovering waste have on the environment.

4.3.1 Relate the history of technological development dealing with power generation. [3.204, 3.301, 3.302]

Technological development of power generation can be summed up by the following headings

The Age of Wind and Water

- Before the modern era, humans depended upon their own muscles, draft animals and wind and water to generate power. Historically there are many examples of water wheels and windmills used to directly transfer their energy to some purpose. In most of these cases the use of mechanical energy was for a direct purpose, in close proximity to the source of power. The earliest forms of hydro-power are found in France, where dams were created to direct water to giant mills that ran on the power of the water itself.

The Age of Steam

- Late in the 1700's and early 1800's the steam engine entered the industrial world. Originally developed by Thomas Savery and Thomas Newcomen for use in coal mines as pumps, the advanced steam engine, described in the external combustion engine section, was invented by Thomas Watt. These engines, burning wood to start, used steam and its pressure as a method of producing power. It converted the power from the combustion of the material into mechanical power. Later in the 1800's, the combustive material was changed to coal, which also began the development of fossil fuels. These engines were the first step in allowing industries to become independent of their power bases. No longer would mines and mills be forced to locate close to water sources. The steam engine and its methods actually form the basis of modern combustion-based power generation stations, although the methods used today are much more advanced, the core concept remains the same.

The Age of Electricity

- Later in the 1800's electrical power came on the scene and with it a revolution in how energy was used. Mechanical and chemical energy was now converted into electrical energy and that energy was transferred over great distances to be used. Thomas Edison and Nicola Teslahad a tremendous impact at this time, developing the light bulb and alternating current respectively. On the one hand the light bulb created a market for electrical power, and on the other, alternating current allowed that power to be transferred over great distances. With the advent of electrical motors the ability to transfer power over distances allowed industries to be located further away from their power sources, and inevitably lead to the widespread use of electricity.

- Hydro power dams became hydro-electrical, and steam started to be used to drive armatures. Coal fired electrical generation plants started dotting the landscape in Europe and North America.

The Atomic Age

- With the widespread use of electricity in the early to mid 1900's, different ways to produce the power started to be explored. Steam turbines and fossil fuel generating plants became more efficient, and the demand for electricity grew. With the advent of the second world war and the enormous amounts of power required to run the manufacturing centers of the major powers of the time, more ways to generate electricity needed to be found. Nuclear power became that answer after the war. Nuclear power plants, based on the early work of Marie Curie and followed up by Enrico Fermi, started to appear across the world. The power generation was relatively cheap, but the side effects of nuclear waste and the dangers of the technology created issues and several incidents in the past 30 years, such as Three Mile Island and Chernobyl did not help. Still it is the third highest produced power in this country.

Alternative Power

- Using the wind, water and the sun to generate power would be familiar to someone from 400 years ago. The technologies of the conversion of energy make it possible. Photo-voltaic cells, wind turbines, wave power, tidal power, geothermal, hydro-power all of these have started to surge in the past few years. In some ways it is easy to see why, as the high cost of fossil fuels, the unpopularity of nuclear power and the decrease in areas to use for hydro-electric dams have lead to an increase in funding for these "alternatives".

4.3.4 describe the common qualities of power generation technology

All common standard power generation technologies use a turbine and pressurized liquid of some sort. In coal and oil fired generation plants, water is heated to steam using a combustive fuel, and in the conversion, pressure is created in a series of pipes. That steam under pressure is forced through a turbine that turns an armature within a generator that produces electricity. In almost every case of heat/steam power generation this is how it is done. Variations may occur but the central action is the same.

In a step by step format that process can be outlined as:

- Step 1 - Water is heated
- Step 2 - Water converts to steam
- Step 3 - The conversion creates high pressure due to the greater space water takes up as a gas in comparison to a liquid
- Step 4 - The high pressure steam drives through a series of pipes and spins a turbine
- Step 5 - Turbine spins an armature within a generator

Obviously hydro-electric power generation occurs in a more direct fashion, with the water spinning the turbine directly. This is also true of the new technologies, such as wind and solar, where wind power turns the armature directly and solar cells create electricity as a process in the photo-voltaic cells.

Unit 5

5.1.3	review the legislation dealing with the use of windmill and solar power generation methods in Newfoundland and Labrador [1.405]	Excerpts from the Newfoundland and Labrador Energy Plan. Some homeowners and small business operators have requested permission to install small generation units to produce power for themselves with the ability to feed some back into the system when they can produce more than they need. The Provincial Government will ensure that regulatory support is in place for customers who wish to develop these alternatives themselves on a small scale, through a net metering policy. NLH and Newfoundland Power have told Government they will make a joint proposal to the PUB to implement net metering for small-scale renewable energy sources, with due regard for safety, the environment and the community. There are currently two limits in place by Newfoundland Power & Newfoundland and Labrador Hydro on wind generation. These are an 80 MW Economic Limit and a 130 MW Technical Limit. The 80 MW economic limit is the amount of wind generated electricity that is economically feasible to be added to the existing grid. The second higher limit of 130 MW is and estimate of the total amount of power that can be produced, in excess of what already exists, considering the current electrical grid in our province. We have no feasible route to export any more surplus thus it is of no use to produce it. This is the significance of the Lower Churchill 2009 limit.
5.2.2	outline the historical use and development of windmill technology [1.405]	Ancient Persians used wind energy to pump water before the birth of Christ. The world was explored by wind-driven ships long before engines were invented. The Dutch refined its design and used wind energy to drain marshes, and lakes. Eventually this technology was exported to the New World. As recently as the 1920s, over a million wind turbines pumped water and provided electricity to farms in North America.
5.2.3	describe the planned wind-farm technology to be used in Newfoundland and Labrador [1.404, 1.405, 2.404]	Specifications of the projected windfarm. Points to emphasize: • $45 Million Investment • 27 MW Installed Capacity • 38 Vestas V47 Wind Turbines • Interconnection at NP Laurentian Substation • 15 km of access roads

- 8 km overhead transmission line
- 95 GWh annual generation (enough to power 10 000 homes)
- Reduction of 75 000 tons of CO2 Greenhouse gas annually
- Located between Lawn & St. Lawrence
- A second site is proposed for Fermeuse producing another 25 MW
- St. Lawrence's 27 MW + Fermeuse's 25 MW leaves ~ 30 MW for future development, if we factor in NL Power & NL Hydro 80 MW Economic Limit (Described in note to follow).

5.3.2 outline the historical use and development of solar cell technology [1.405]

Photoelectric Effect

Discovered in 1839 by Edmund Bequerel, who noted that when certain substances were exposed to sunlight they produced a minute electrical current. The photoelectric effect was further refined and described by Albert Einstein in research that won him a Nobel prize in 1905. The first actual module was built by Bell Laboratory in 1958. It was very expensive and had little use potential. That is until the race for outer space began in the 1960's. Solar cell technology came into its own over this decade as satellites and capsules used them for a power source. They were also extensively refined and advanced such that the technology became cheaper and easier to produce. The next big jump for the solar cell occurred in the late 1970's and early 1980's. The energy crisis and the high cost of petroleum-based fuels moved solar cells from space to the main stream and a variety of products for home-generation and off-the-grid became available.

5.4.1 describe the components and function of a standard residential electrical service [1.405]

Main hot bus – distributes 120 Volts electricity to the household electrical system. Current electrical code requires two hot bus bars be included in the assembly of the panel. (Note: several appliances in the house require 220 volts).

Neutral bus bar-Bus bar within the service panel to which all neutral wires are attached to complete the circuit.

Ground Wire- Terminals for ground wires bundled with NMC cables are attached to the panel or may be attached to a ground wire bus.

Main Power switch- largest switch contained in the panel, usually located at the top of the panel. This switch is used to control the flow of electricity into panel. The main is usually labeled with the number of amps that it is rated for.

Breakers-the most common component found in the service panel. Breakers are protection device that limits the amount of current that can be safely controlled within the circuit. If the limit is exceeded the breaker will trip (turn off) until the excess load is removed. The breaker can then be reset and the circuit restored. Note that a 15 amp breaker is capable of carrying 1700 watts of power.

GFI Breakers- special breakers that are installed in areas where the risk of shock are increased such as a bathroom of outside receptacles. In some cases a GFI receptacles maybe used which are located at site of access. These units are recognizable by the reset and test button built into the unit.

5.5.3 explain how a fuel cell can produce electricity [1.405]

A fuel cell is an electrochemical energy conversion device that converts chemicals directly into electricity. Fuel cells converts hydrogen and oxygen into water as a product of this process electricity is produced. Fuel cells will run indefinitely as long as the chemicals continue to flow into the cell.

A basic fuel cell is made up of an electrolyte layer which separates the reactants from each other and prevents them from mixing. The electrodes are catalysts where the electrochemical reactions occur. Bipolar plates are used to conduct the electricity out of the cell to the consuming device.

Fuel is constantly feed to the anode side of the electrolyte side of the cell and an oxidant (oxygen) is supplied to the cathode. An electrochemical reaction takes place at the electrodes to produce electricity.

5.5.4 differentiate between the types of fuel cell and their applications [1.405]

Types of fuel cells - Points to emphasize:

- Polymer Exchange Membrane Fuel Cells - Holds the most promise of being used in transportation applications. Uses water as an electrolyte, and has low operating temperature. This is the type of fuel cell that is part of the Ballard fuel cell experiments.

- Solid Oxide Fuel Cells - Used in large scale stationary power generating applications. It use very high temperature.

- Alkaline Fuel Cells - Oldest of the cells used in US space travel, susceptible to contamination and expensive to produce. Uses alkaline electrolyte

- Molten-Carbonate Fuel Cell - Used in large scale energy production facilities. High temperature.

- Phosphoric-Acid Fuel Cells - Slower in its endothermic reaction, not suitable for the transportation industry. Uses acid as its electrolyte.

- Direct Methanol Fuel Cell - Expensive to operate uses large amounts of platinum as an electrolyte.

5.6.2 outline the historical use and development of heat pump technology [1.401, 1.405]

The Paleo-Indians used hot-springs as a source of geothermal energy as early as 10,000 years ago. The ground source heat pump is not new technology and has been used in different forms for many years.

In 1852 Lord Kelvin developed the concept of the heat pump.

In the 1940's Robert C. Webber further developed the idea of using this technology as a heat source. While experimenting with his deep freezer he noticed that when he dropped the temperature of the freezer there was rise in the temperature of the fluid in the pipes after it circulated through the system. He ran this hot fluid to his home boilers to heat the water and provide heating in the house.

He also developed the idea of the taking the heat from the ground through a system of pipes and Freon gas and using this to heat the home and thus developed the ground source heat pump.

In the 1970's Dr. James Bose, a professor at Oklahoma State University, used this technology to take heat from one source (swimming pool) and put it through pipes in the ground to cool it. This was the beginning of the new era in geothermal systems.

5.6.3 differentiate between the different types of heat pump installations [1.401, 1.405, 2.401]

There are two types of ground source heat pumps:

Closed Loop System

This system uses a continuous loop of pipe buried under ground. The solution inside the pipe gets cooled by a refrigeration system to a temperature lower than the surrounding soil. As it circulates through the pipe it absorbs the heat from the soil and this heat gets extracted when it reaches the compressor again.

Open Loop System
This system uses an underground water source. This water is extracted directly to the heat exchanger and the heat is taken out. The water is then released to an above ground body of water or down another well.

There are two types of air source heat pumps

Air to air
This is the most common system in use today. It takes the heat from the outside air and transfers it to a forced air system inside the home. This works in reverse for cooling.

Air to water
Works in a similar way as air to air. This system takes heat from the outside air and uses it to heat water in a hydronic system inside the home. Once again the system works in reverse for cooling. The heat pump extracts the heat from the water inside the hydronic system of the home and pumps it to the air outside of the home.

5.7.2 define R-value in terms of energy loss over square footage of a material [1.405, 3.401, 3.402]

Delineation

- R-value
- U-value
- Methods of heat transfer
  - Conduction
  - Convection
  - Radiation

R- value is defined as A commercial unit used to measure the effectiveness of thermal insulation. Thermal conductance is measured in BTU's of energy conducted times inches of thickness per hour of time per square foot area per Fahrenheit degree of temperature difference between two sides of the material. The R value of the insulator is defined to be the inverse of the thermal conductance per inch.

U-Value: A commercial unit of thermal conductance. Refers to the conductance through an insulator as measured in BTU's of energy conducted times inches of thickness per hour of time per square foot of area per °F of temperature difference between the two sides of the material. The U factor is numerically equal to 1 divided by the R-Value. This unit is also referred to as the overall heat transfer coefficient and is basically the reciprocal of R-Value. This value measures the rate of heat transfer through a building material and as such a smaller U-Value is better. Knowing the U-Value of a given building material and the temperatures on both sides of the material one can calculate the rate of heat loss for that structure. More precisely $R = 1/U$

5.7.3 Differentiate between different insulation types and their appropriate use in residential construction/ renovation. {1.401, 1.405, 2.404]

Delineation

- R-value
- Batt or blanket insulation
- Loose-fill insulation
- Rigid board insulation
- Spray-foam insulation
- Radiant Barrier Insulation

Batt or Blanket insulation

One of the most common types used in houses in this province is the batt or blanket insulation. Sometimes associated with the brand name, this insulation is usually fiberglass based and pink. The insulation is called batt, because that is the way it is created and packaged.

Loose-fill insulation

Defined as small particles of fiber, foam, or other materials that can conform to any space without disturbing any structures or finishes. Its ability to conform makes it well suited for retrofits and for places where it's difficult to install some other types of insulation. There are three common types of loose fill including cellulose, fiberglass and mineral wool. Each of the types has different R-Values, densities, and weights that should be considered for the various applications. Cellulose has the highest R-Value per inch thickness.

It is important to note that each of the three types is produced using recycled waste material. Cellulose made primarily from recycled newsprint, most fiberglass contains 20% - 30% recycled glass and mineral wool is usually produced from 75% post-industrial recycled content.

Over time loose-fill insulation can loose some of its R-Value because of settling, especially in attic cavities. Cellulose settles more than rock wool or fiberglass by up to 20% compared to 2%-4% for the latter. Obvious solution is to install 20% more to offset the settling. (Settling can be avoided in wall cavities by completely filling cavity to proper density).

Safety:

- Insulation should cover top plate of wall but not eave vents.
- Electrical devices require 3 inches clearance.
- Pipes for heat sources such as stoves should only be insulated with fiberglass or rock wool as cellulose will smolder.
- Some research suggests that fiberglass particles can cause cancer if inhaled and that the additives for fire retardants and insecticides may also be harmful to breathe.
- Care must be taken to ensure insulation fibers are not drawn into air distribution systems by properly sealing ducts.
- Proper PPE must be worn during installation including respirator, eyewear, and clothing such as gloves, long sleeved shirts, and pants to minimize contact.

Rigid Board Insulation:
Usually made of fiberglass, polystyrene, or polyurethane and comes with very high R-Values ranging from R-4 to R-8 per inch. Often used below grade on foundation applications as well as exterior of walls.
In conjunction with damp-proofing rigid insulation on a foundation aides with site drainage as well as reducing interior condensation in basements.
Three basic types of rigid board insulation include expanded polystyrene (EPS), extruded polystyrene (XPS), and polyisocyanurate (ISO). EPS has the lowest R value of the three and ISO having the highest of the three.

Spray-foam Insulation:
One of the best forms of insulation as far as R-Value is concerned. Has been around for years for use in appliances such hot water boilers and refrigerators but is relatively new in the housing industry. Its major advantage is that it can virtually eliminate air infiltration by sealing and filling even the smallest cracks. It is more expensive than more traditional insulating methods, can really only be used during new construction and is quite messy. It can sometimes also delay other subcontractors such as electricians and plumbers.

- Some types of spray foam insulation actually add structural strength to a wall or ceiling. It increases its shear and racking strength.
- It is sprayed on by professional installers.
- Classified as an air barrier material.
- Works well to dampen common household noises such as plumbing noises.

Radiant Barrier Insulation:
Usually consist of a thin sheet or coating of highly reflective material such as aluminum that is designed to reflect heat or thermal energy away from a structure to keep it cool, or attracting it to keep it warm. Most often these barriers are rigid or semi-rigid boards. Installed correctly in an attic situation a radiant barrier system can help to cool an attic in summer and absorb heat during winter months. The use of any insulation requires good skin, eye and breathing protection. Workers involved in the installation of insulative materials should wear good strong gloves, have their body covered by rough material to prevent irritation of the skin, and, as in all residential construction aspects, wear safety eye wear. In this instance as the risk is based in small airborne particulates the most appropriate type of safety eye-wear is goggle type.

The most serious risk to the installer in this instance is to their breathing. The same small airborne particulates that are a risk for the eye or skin are a much more pronounced risk for the lungs and air ways. A CSA approved breath mask should be used when handling any type of insulation at all times.

Beyond the hazards to the individual when installing such materials, there are inherent hazards that need to be considered within the construction area. Some types of insulation are flammable and need to be covered by an approved fire-rated material and not left open to the air.