Public and Catholic District School Board Writing Partnerships

Course Profile

Transportation Technology

Grade 11
College Preparation
TTJ3C

- *for teachers by teachers*

This sample course of study was prepared for teachers to use in meeting local classroom needs, as appropriate. This is not a mandated approach to the teaching of the course. It may be used in its entirety, in part, or adapted.

Course Profiles are professional development materials designed to help teachers implement the new Grade 11 secondary school curriculum. These materials were created by writing partnerships of school boards and subject associations. The development of these resources was funded by the Ontario Ministry of Education. This document reflects the views of the developers and not necessarily those of the Ministry. Permission is given to reproduce these materials for any purpose except profit. Teachers are also encouraged to amend, revise, edit, cut, paste, and otherwise adapt this material for educational purposes.

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Course Overview
Transportation Technology, Grade 11, College Preparation, TTJ3C

Secondary Policy Document: *The Ontario Curriculum, Grades 11 and 12, Technological Education, 2000.*

Course Description

This course examines the infrastructure required for the operation of land, air, and/or marine vehicles. Students design, construct and modify vehicles, and apply safe work practices and procedures using current technology. Students also develop effective communication and teamwork skills when developing solutions to managing vehicle support systems, investigate the educational requirements for career opportunities in the transportation sector, and analyse the impact of transportation technology on society and the environment.

This course is designed to allow students to explore the wide range of transportation systems, energy sources, power systems, and related career opportunities for technicians, technologists, and engineers. While many activities are written for the automotive sector to reflect the direction of the majority of schools in Ontario, all can be adapted to any of the multi-faceted areas of transportation, as local resources and needs dictate. As a major focus of the course, students examine the social and environmental issues related to design choices in air, land, and marine mass transportation systems.

How This Course Supports the Ontario Catholic School Graduate Expectations

Professionalism in a technical field is presented as opportunities to serve God both within the students own community and globally. Through the examination of the choices that a student can make in a technological world, students develop their God-given potential and learn to make meaningful contributions to social justice issues such as protecting the environment, moral and ethical use of technology in the workplace, and striving to enhance the quality of life in our communities. Individual decision-making and collaborative efforts are explored as students develop knowledge and skills applicable in the critical analysis of transportation infrastructures, in light of the ethical stewardship of our environment and world communities. Students reflect on respect for the environment and wise use of resources, while acknowledging the diversity and interdependence of the world's various groups, people, and cultures. Applying the opportunity to improve the lives of others will be integral to success.

Since transportation systems can be major sources of pollution, threatening human health and the ecological integrity of our planet, this course includes education related to environmental justice set within the context of the Christian faith. Furthermore, social justice enters the picture when transportation policy neglects affordable public transportation. This course provides opportunities for critical reflection of these issues and responsibilities.

Course Notes

The activities in this course are designed to address a set of themes related to the diversity of transit systems and transportation infrastructures. Transportation is addressed in a global perspective in direct relationship to environmental and human needs issues. The student-centred, activity-based delivery of course materials provides opportunities to develop individual and group skills. Time management skills are essential as students are given an opportunity to design and construct models to solve transportation problems following organized plans.

Teachers are encouraged to use the Grade 10 Transportation Course Profile as a resource in planning activities in Grade 11. The Grade 12 policy document outlines the directions students would normally pursue and can give teachers guidance for course planning. In addition to the Grade 12 Transportation course (TTJ4C), students may be directed to Cooperative Education or School to Work Programs for further exploration of interest in the subject.

Special considerations are made in the course to incorporate specific health and safety guidelines such as the Workplace Hazardous Materials Information System (WHMIS). Teachers must note safety considerations and regulations from such organizations as the Industrial Accident Prevention Association (IAPA) and the Workplace Safety Insurance Bureau (WSIB) that impact the transportation industry and in turn, the technical classroom. Safe practices in the workshop must be addressed and reinforced throughout the course to ensure students learn and practice safe operating procedures in the classroom.

Teachers must address security and safety issues on the Internet by implementing school board policies on appropriate student use and access to Internet services.

Awareness of careers in transportation can be accomplished in a variety of ways, e.g., job shadowing, computer/Internet research, field trips, guest speakers, and introduction to Co-op and OYAP programs. Investigations into local transportation infrastructures will help students connect classroom concepts with work environments.

Units: Titles and Time

* Unit 1	Transportation Systems	35 hours
Unit 2	Managing Transportation Facilities	15 hours
Unit 3	Conversion of Energy	20 hours
* Unit 4	Vehicle Systems Design	40 hours

* These units are fully developed in this Course Profile.

Unit Overviews

Unit 1: Transportation Systems

Time: 35 hours

Unit Description

Students explore the vast array of land, marine, and aerospace transportation systems in use throughout the world. Students research systems and vehicles used in moving people and products, and identify design considerations, including energy use and methods of power generation. Students analyse and compare various modes of transportation, in terms of environmental and social impacts, both locally and globally.

Students examine design considerations, solving problems of moving people and goods, both in mass transit and in personal transportation. Students examine issues related to infrastructure, human needs, economics, and historical perspectives. Through their project work, students develop attitudes and values to promote social responsibility, human solidarity, and the common good.

Unit 1 Overview Chart

Cluster	Expectations	Assessment	Focus
1.1	TFV.03, TFV.04; TF2.01, TF2.02, TF2.03, TF2.04; ICV.04; IC1.01, IC1.02; CGE2a, 3b	Knowledge/Understanding Thinking/Inquiry Communication Application	Identify and analyse transportation systems in terms of comfort, efficiency, cost and environmental and societal impacts
1.2	TFV.01, TFV.02; SPV.01, SPV.03, SPV.04; ICV.01; TF1.01, TF1.02; SP1.01, SP1.03, SP3.01; IC1.03; IC2.06; CGE3c, 4a	Knowledge/Understanding Thinking/Inquiry Communication Application	Develop solutions to problems within transportation systems and methods of implementing modifications
1.3	SPV.01, SPV.04; SP1.04, SP1.05; SP2.01; CGE3e	Knowledge/Understanding Thinking/Inquiry Communication Application	Construct a dynamic model to display modifications
1.4	TFV.02, TFV.03; SPV.03; TF1.01; SP1.06; SP3.01, SP3.05; CGE5a, 5e	Knowledge/Understanding Thinking/Inquiry Application Communication	Communicate problems, ideas, and solutions

Unit 2: Managing Transportation Facilities

Time: 15 hours

Unit Description

Students study issues of quality control, inventory control, human resources, and the ways owners and managers ensure compliance with current health and safety, vehicle safety, and other legislation for specific transportation facilities. Through the activities in this unit students learn the issues involved in owning and operating their own transportation facility, which could include service centres, testing facilities, transit hubs, shipping and receiving terminals, etc. A key focus of this unit is to investigate moral and ethical business practices and social responsibilities.

Unit 2 Overview Chart

Cluster	Expectations	Assessment	Focus
2.1	ICV.01, ICV.02, ICV.03; IC1.02, IC1.03; IC2.01, IC2.03, IC2.04, IC2.05, IC2.06; CGE2b; CGE3f; CGE7d, CGE7j	Knowledge/ Understanding Thinking/ Inquiry Communication Application	Health and safety and vehicle safety
2.2	TFV.01; TF1.02; SPV.01, SPV.03; SP1.01, SP1.02, SP1.03, SP1.04, SP1.06; SP2.03, SP2.04, SP2.05; SP4.03; CGE2e; CGE3f; CGE7j	Knowledge/Understanding Thinking/Inquiry Communication Application	Small business management

Unit 3: Conversion of Energy

Time: 20 hours

Unit Description

Students take an in-depth look at methods used to convert energy to power vehicles, and the effects of energy consumption on society and the environment. Students study engine design and classifications, and the scientific principles used in energy conversion in traditional and alternative fuel engines. Students acquire understanding of basic engine concepts, terminology and operations of piston engines, rotary, turbine, and reaction engines, hydrogen fuel cells, and devices used to reduce emissions. Students perform appropriate technical practices involved in engine operations and diagnostic flow charts. Activities range from engine repairs and testing, model-making and reporting, experimentation with electric motors, and a study of hydrogen fuel cell technology. Students are also made aware of their ethical duties and social responsibilities in ensuring care and stewardship of the environment.

Unit 3 Overview Chart

Cluster	Expectations	Assessment	Focus
3.1	IC2.03, IC2.04, IC2.05, IC2.06; ICV.02, ICV.03 CGE1I; CGE7I; CGE2b	Knowledge/Understanding Thinking/Inquiry Communication Application	Introduction to (OHSA) WHMIS Engine classifications
3.2	TF3.01, TF3.02, TF3.03; SPV.02; TF3.03; SPV.04 CGE3f	Knowledge/Understanding Thinking/Inquiry Communication Application	Scientific principles, engine concepts, terminology
3.3	SP3.02, SP3.04 CGE2b	Knowledge/Understanding Thinking/Inquiry Communication Application	Develop computer engineering drawing of one integral part of the internal combustion engine
3.4	SPV.02, SPV.03, SPV.04; SP2.01; SP4.01 CGE2b	Knowledge/Understanding Thinking/Inquiry Communication Application	Specific engine measurements and drawings
3.5	SPV.02, SPV.03; SP2.03; SPV.04; SP2.01, SP2.04, SP2.05 CGE2c; CGE3f; CGE7i	Knowledge/Understanding Thinking/Inquiry Communication Application	Service facility plan

Unit 4: Vehicle Systems Design

Time: 40 hours

Unit Description

In this culminating unit, students apply their knowledge and skills in developing a model or prototype vehicle system to solve specific problems in transporting goods or people. Vehicle designs may be related to aerospace, land, or marine systems studied in Unit 1, testing devices used in Unit 2 and/or incorporate power systems studied in Unit 3. Project selection may be drawn from vehicle components or systems as found in concept cars or motor-sport, replacement or after-market accessories, testing devices, or special use modifications such as those developed for the handicapped. In developing vehicle systems (or improving existing ones), students consider such parameters as economic, environmental, and production methods, as well as design parameters such as ergonomics, efficiency, aerodynamics, and mechanical engineering concepts. Students reflect and create meaningful solutions using a holistic approach to problem solving and decision making with an informed conscience and a goal to work towards the common good.

Unit 4 Overview Chart

Cluster	Expectations	Assessment	Focus
4.1	TVF.01, TVF.02; TF1.01, TFI.02; SPV.03, SPV.04; SP1.02, SP1.03, SP1.04, SP1.05; ICV.01, ICV.02; IC1.02; IC2.01 CGE2c; CGE3e, CGE3f; CGE4a, CGE4b, CGE4c	Knowledge Inquiry Communications Application	Design solutions to problems in vehicle engineering, (analyse, model, draw, test)
4.2	TFV.01, TFV.02, TFV.04; TF1.01, TF1.02; SPV.03, SPV.04; SP1.04SP1.05, SP2.01, SP2.02; SP3.01, SP3.05; SP4.02; ICV.02; IC2.01 CGE3f; CGE5f, CGE5g	Knowledge Inquiry Communications Application	Fabricate and test solutions to vehicle design engineering problems

Teaching/Learning Strategies

- The study of transportation involves generating solutions to problems in transporting goods and people via air, space, land, and marine environments. This course requires a hands-on, project-based approach that incorporates individual and team efforts, a flexible process for generating ideas, and a variety of materials and tools to model, test, and communicate solutions. Historical analysis and examination of local solutions and problems is critical to the development of students' appreciation of engineering and scientific concepts, as well as social and environmental issues.
- In a transportation design project, the teacher provides students with a design brief that describes: the problem to be solved; the constraints or criteria to be met in the solution; and in many cases, possible paths to take to develop a viable solution. Activity initiation may take place with the whole classroom, or with select groups.
- It is important to provide students with the assessment criteria before initiating the project and to discuss the strategies for attaining their maximum potential. Teachers should also discuss the production and maintenance of a portfolio as each activity is begun.
- Teachers may elect to provide students with a list of the course projects at the beginning of the course, or to introduce them in sequence. This lends itself to a variety of strategies for learning that is dependent on the project, the level of student understanding and experience, and the availability of local facilities and resources.

Possible teaching and learning strategies in a design project include:

- **Group collaboration:** students work in teams or with partners to accomplish specific tasks. Individuals with differing strengths, skills, and knowledge work together to solve problems. Group learning provides high levels of student engagement and interdependence. Conflict resolution is utilized in the observation of the student's ability to resolve differences in a mature manner. Teachers establish a learning environment modelled after a service shop, engineering office, or race team prototype shop dependent on the project.
- **Individual effort:** students work independently to accomplish specific tasks or research topics of interest. This may include reporting or completing individual tasks related to a group project. Time management skills are addressed as both individual and group deadlines are clearly posted and adhered to.
- **Class discussion:** students actively participate by taking turns discussing relevant topics in the units of study. Teachers may direct discussions by posing initial questions, by demonstrating specific procedures or by presenting a media topic related to the current activity. Student-to-student conferencing in groups should be done with outlined direction.
- **Theoretical study:** students learn concepts and theory in application through the study of appropriate texts and manuals. Theoretical concepts are taught through Socratic lessons provided by the teacher or invited guests, or through assignments that involve research and study into technical procedures that apply to the current activities.

- It should be noted that important issues such as safety (WHMIS, OHSA) must be reinforced throughout the course. Following initial discussions and acceptable testing results, a safety passport is assigned to each student. Teachers reintroduce specific related safety topics as required.
- It is important that teachers distribute assessment/evaluation rubrics at the beginning of each activity to guide students' development and to direct student efforts.
- A key component of this course is that students be made aware of career opportunities in the field of transportation. Strategies such as inviting guest speakers, conducting field trips or industry visits, participating in community-based projects, encouraging and marketing job shadowing, and participation in co-op or apprenticeship placements are highly recommended. Postgraduate studies and the procedures in applying to college programs and apprenticeships should be highlighted, to reflect the wide range of opportunities for students to easily explore areas of interest. Teachers could also incorporate investigations into career opportunities in transportation throughout the course.

Assessment & Evaluation of Student Achievement

- Assessment and evaluation criteria must be clearly explained to students at the beginning of the course and at the onset of each activity. Performance assessment includes analysis of the completed task and of students' use of correct procedures and safe conduct. Knowledge acquisition can be evaluated through testing, written reports and assignments, and formal student presentations. Teachers assess individual students' progress through daily observation and self and peer assessment. Evaluation of thinking/inquiry skills may take the form of testing for rationalization of design choices and evaluating the development of ideas into concrete products.
- Seventy per cent of the grade will be based on assessments and evaluations conducted throughout the course. Thirty per cent of the grade will be based on a final evaluation in the form of an examination, performance, essay, and/or other method of evaluation.

- It is important for the teacher to provide multiple opportunities for all students to participate in the activities. Teachers must evaluate students individually, even while working within a collaborative group. Possible strategies include:
  - individual deliverables, such as a research report, or detailed work order;
  - a daily job or task sheet, to be signed by students and the teacher (**Note:** these sheets can be attached to an end report, clearly indicating each group members respective accomplishments.);
  - individual conferencing (i.e., teacher-to-student discussions to assess development and to encourage or motivate);
  - development of individual portfolios, skills profiles, log books, or time cards.

Assessment Category	Methods of Assessment
Knowledge/Understanding	Written, oral and/or practical tests Student/teacher conferencing Class presentations Formal projects Teacher observation Written assignments Written reports on diagnostic tasks
Thinking/Inquiry	Sequenced procedural lists Written reports on diagnostic tasks
Communication	Report writing Class presentations Customer relations Notebook
Application	Teacher observation of safe work habits Student/teacher conferencing
Final Assessment	Teacher observation of hands-on skills Written testing Problem-solving and/or design tasks

Accommodations

Various accommodations may be made throughout the program as required. They include one-to-one teaching/conferencing, adaptation of handouts, small group learning, and/or peer tutoring. Activities are monitored and adapted to meet the needs of all learners by applying various accommodations such as allowing increased time for activities, and facilitating peer tutor assistance when possible. Teachers using the course profiles are expected to be acquainted with students Individual Education Plans (IEPs) and the unique learning characteristics of their individual students in order to make the necessary accommodations.

Specific accommodations in the transportation activities include:

- additional assistance for physical tasks;
- additional language resources (especially for technical terms);
- templates or additional templates to assist in completing drawings or reports;
- peer tutoring or additional help in record-keeping, diagnosing, measuring, computing or fabricating tasks;
- examples of completed assignments;
- simulated faults for service challenges;
- one-on-one assistance in sequencing tasks.

Resources

Various resources are used throughout the course including the school Library/Resource Centre, public library, research software, transportation textbooks, websites, equipment and vehicle technical manuals, instructional videos, and community industry experts. Special tools may be required for several procedures, such as compression testing. An electronic service manual system is a valuable asset as students locate and print specifications and procedures for work performed. These copies may be inserted into students' notebooks. Other resources, such as a teacher-developed worksheet of procedures and observations, are to be completed by students at predetermined points in the activity.

Print

Carlson, D. Lisa Wormser, and Cyrus Ulberg. *At Roads End: Transportation and Land Use Choices for Communities*. Island Press, 1995. ISBN 1559633387

Daiber, Robert and Thomas L. Erekson. *Manufacturing Technology Today and Tomorrow*. United States: Glencoe/McGraw-Hill Educational Division, 1991. ISBN 0-02-675751-6

Erjavec, Jack *Automotive Technology, A Systems Approach*, 3rd ed. Columbus State Community College: Delmar Thompson Learning, 2000. ISBN 0-7668-0673-1

Forester, John. *Bicycle Transportation: A Handbook for Cycling Engineers*. MIT Press, 1994. ISBN 0262560798

Giachino, J.W., William Weeks, and Elmer Brune. *Welding Skills and Practices*, 4th ed. United States: American Technology Society, 1974. ISBN 0-8269-3042-5

Komacek, Stanley, Anne Lawson, and Andrew C. Horton. *Manufacturing Technology*. United States: Delmar Publishers Inc., 1990. ISBN 0-8273-3462-1

Krar, S.F. and J.W. Oswald. *Technology of Machine Tools*, 3rd Ed. United States: McGraw-Hill Ryerson, 1987. ISBN 0-07-549025

Sperling, Daniel. *Future Drive: Electric Vehicles and Sustainable Transportation*. Island Press. 1995. ISBN 155963328X

Wells, Alexander T. *Air Transportation: A Management Perspective*. Broward Community College: Brooks/Cole, 1997. ISBN 0534534783

Websites

Note: The URLs for the websites have been verified by the writer prior to publication. Given the frequency with which these designations change, teachers should always verify the websites prior to assigning them for student use.

Scotty's Centre for Technology Education (Scotty's Design Shack, on design teaching) - http://www.millenniumwave.com

Air Quality Program – Pollution Probe - http://www.pollutionprobe.org/air/index.htm

American Public Transportation Association - http://www.apta.com/

How Things Work - http://www.howthingswork.com/

Inductrac - http://www.llnl.gov/str/Post.html

Industry Canada - http://strategis.ic.gc.ca/sc_indps/sectors/engdoc/tran_hpg.html

Microsoft Office Update Page - http://officeupdate.microsoft.com/articlelist/o2kPowerPointArticles.htm

Provides "How to" and "Tricks and Tips" articles for using Microsoft Power Point software

Presentations.Com - http://www.presentations.com/ Provides several links on strategies for a good presentation and information on software applications.

Project California - http://merkury.saic.com/calif/maglev.html

Society of Automotive Engineers - http://www.sae.org/index.htm
The Subway Page - http://www.reed.edu/~reyn/transport.html
Transportation Research: The University of Leeds - http://www1.leeds.ac.uk/~yimling
Transport Canada - http://www.tc.gc.ca
Catholic Conservation Centre - http://conservation.catholic.org
Online Ethics Centre for Engineering and Science - http://onlineethics.org

CD-ROM

Microsoft Encarta Encyclopaedia. CD-ROM. Microsoft #X03-52495
Presentation software such as Corel Presentation or Microsoft Power Point
Video editing equipment or software such as Avid Cinema.

Videos

Several video tapes are available from:
The Learning Tree www.autovideo2000.com
ICS Learning www.icslearning.com

OSS Considerations

The Grade 11 College Preparation Transportation Technology Course is designated as a Technological Education program. (See The Ontario Curriculum, Grades 9 to 12, Program Planning and Assessment, 2000 for a description of the different types of secondary school courses.) Students can use this course as an additional compulsory credit, (one credit from Science [Grade 11 or Grade 12] or Technological Education [Grade 9 –12], or as an optional credit.) This course is designed to provide students with a broad educational base that will prepare them for their studies in Grade 12, Cooperative Education or the Ontario Youth Apprenticeship Program, and to instil in them the need for life-long learning in the workforce.

Students are involved in practical and theoretical aspects of transportation technology. The curriculum provides opportunities for students to undertake hands-on practical activities as well as to conduct research and analysis. There is a wide range of teaching/learning strategies and accommodations to meet the needs of all students. Anti-discrimination education, equity/social justice issues, career goals/cooperative education, conflict resolution/violence prevention, and community partnerships may be addressed in the day-to-day progression of the course. All of these support many of the Ontario Secondary School Policies.

Career exploration throughout all units is made available to students with specific reference to *Choices into Action: Guidance and Career Education Program Policy for Elementary and Secondary Schools, 1999.*

Coded Expectations, Transportation Technology, Grade 11, College Preparation, TTJ3C

Theory and Foundation

Overall Expectations

TFV.01 · apply the design process to develop solutions, products, processes, or services in response to challenges or problems in transportation technology;

TFV.02 · describe how materials and processes are used to produce solutions to meet human needs and wants related to transportation;

TFV.03 · identify the impact of the movement of people and goods on vehicle systems and modes of transportation (highway, rail, air, water, pipeline);

TFV.04 · describe the forms of energy used to power vehicles and transportation systems and explain the different types of energy conversion used for each.

Specific Expectations

The Design Process

TF1.01 – explain how human needs or wants related to transportation can be met through a new or improved vehicle or system;

TF1.02 – apply the following steps of the design process to solve a variety of transportation technology challenges or problems:

- ❑ identify what has to be accomplished (the problem);
- ❑ gather and record information, and establish a plan of procedures;
- ❑ brainstorm a list of as many solutions as possible;
- ❑ identify the resources required for each suggested solution, and compare each solution to the design criteria, refining and modifying it as required;
- ❑ evaluate the solutions (e.g., by testing, modelling, and documenting results) and choose the best one;
- ❑ produce presentation and working drawings, sketches, graphics, mathematical and physical models, or a prototype of the best solution;
- ❑ evaluate the prototype and determine the resources, including computer applications, required to produce it;
- ❑ communicate the solution, using one or more of the following: final drawings, graphs, charts, sketches, technical reports, electronic presentations, flow charts, mock-ups, models, prototypes, and so on;
- ❑ obtain feedback on the final solution and repeat the design process if necessary to refine or improve the solution.

Transportation Systems

TF2.01 – describe the importance of transportation systems to maintaining our quality of life;

TF2.02 – explain how people and goods are moved by highway, air, rail, water, and pipeline transportation systems;

TF2.03 – describe the importance of distance, weight, and volume when selecting the most cost-efficient means of transporting goods;

TF2.04 – explain how comfort and speed relate to the selection of the most cost-efficient means of transporting people.

Energy and Energy Conversion

TF3.01 – explain the difference between internal and external combustion engines;

TF3.02 – describe the conversion of energy in reciprocating, rotary, rotor, and turbine engines, and the use of linear motion in vehicle engines and motors;

TF3.03 – describe and evaluate the conversion of an energy source into power in piston, rotary, and jet engines.

Skills and Processes

Overall Expectations

SPV.01 · design and produce models of different mass-transit systems that indicate the advantages and disadvantages of each system;

SPV.02 · use current technology and procedures to service and repair vehicles and transportation systems;

SPV.03 · use a variety of communication techniques to model and communicate product ideas, materials, and specifications;

SPV.04 · use mathematical and language skills and apply technological and scientific principles in the design, construction, and modification of vehicles and infrastructure for various modes of transportation.

Specific Expectations

Organizational Skills

SP1.01 – develop systems for production, marketing, personnel, and financial control related to transportation systems;

SP1.02 – use computers to help develop, operate, and control transportation systems;

SP1.03 – sketch appropriate solutions to defined problems to scale showing orthographic and isometric views;

SP1.04 – use fabrication techniques to mock up or model potential solutions to a transportation technology challenge;

SP1.05 – test materials and products to develop the best solution to a transportation technology challenge;

SP1.06 – select and use appropriate software to develop marketing strategies for a solution to a transportation technology challenge.

Applied Work Practices and Procedures

SP2.01 – select and use a wide variety of hand and machine tool procedures to repair, service, fabricate, and modify a vehicle or a transportation system;

SP2.02 – measure electrical flow, weight, capacity, length, area, volume, and pressure when diagnosing problems in vehicles and transportation systems;

SP2.03 – design and implement an inventory control system for a vehicle service facility;

SP2.04 – plan, organize, direct, and operate a vehicle service facility and evaluate the facility's efficiency;

SP2.05 – recommend appropriate modifications to specific operations of a vehicle service facility.

Communication Skills

SP3.01 – interpret assembly drawings to identify and describe the components of a vehicle or a transportation system;

SP3.02 – develop an accurate bill of material that indicates the specifications and quantity requirements of specific parts of a vehicle or a transportation system;

SP3.03 – develop effective engineering drawings using a computer-aided drafting program to solve challenges in vehicles and transportation systems;
SP3.04 – produce engineering reports that clearly communicate the specifics of a service or a repair;
SP3.05 – prepare and present effective oral reports about a product or process.

Interdisciplinary Applications
SP4.01 – apply mathematical skills in spreadsheet analysis to measure to close tolerances and to control inventory, sampling, costs, and quality;
SP4.02 – apply appropriate scientific principles or practices when selecting and specifying materials, determining forms of energy conversion and power transfer, and designing ergonomically effective vehicles;
SP4.03 – use appropriate language in flow charts, operation and inspection charts, job descriptions, lists of tooling requirements, or quality-control programs.

Impact and Consequences

Overall Expectations
ICV.01 · make informed decisions that take into consideration the social and environmental consequences related to the transportation sector;
ICV.02 · describe, and apply where appropriate, the exemplary practices that are essential to safe work environments and practices;
ICV.03 · describe the role of health and safety legislation related to the transportation sector and to transportation technology programs in schools;
ICV.04 · describe the postsecondary and career opportunities available in the transportation sector following graduation from a college program.

Specific Expectations
Impacts
IC1.01 – describe the consequences of transportation technology for individuals and for society (e.g., by conducting a survey to document how an efficient mass-transit system affects the travel time for a commuter, or by investigating the demographics of commuting and identifying whether the current mass-transit system in their region could handle the anticipated population growth over the next five years);
IC1.02 – describe the possible impact of transportation technology on the environment;
IC1.03 – identify a variety of materials, processes, and waste-management methods that would minimize the negative impact of a transportation-related activity.

Safety and Legislation
IC2.01 – apply safe work practices when performing transportation-related processes;
IC2.02 – identify potential hazards in a workplace related to the transportation sector by conducting safety audits and inspections;
IC2.03 – describe specific components of the Occupational Health and Safety Act (OHSA) related to transportation technology and the actions required to adhere to the act;
IC2.04 – explain the use of the Workplace Hazardous Materials Information System (WHMIS) and the importance of consulting material safety data sheets (MSDS) whenever appropriate;
IC2.05 – recognize the meaning of the hazard labels associated with WHMIS;
IC2.06 – describe and evaluate the legislation pertinent to land, air, and marine vehicles, as well as to working conditions and practices (e.g., legislation regulating such things as emission testing, minimum fuel economy standards, safety specifications, and minimum crash test standards).

Education, Training, and Career Opportunities

IC3.01 – describe the scope of career opportunities in the transportation sector;

IC3.02 – identify specific educational and training requirements for careers in the transportation sector;

IC3.03 – describe career programs related to the transportation sector such as cooperative education and Ontario Youth Apprenticeship Programs (OYAP);

IC3.04 – explain the differences in the roles of technicians, technologists, and engineers, and the educational requirements for each.

Ontario Catholic School Graduate Expectations

The graduate is expected to be:

A Discerning Believer Formed in the Catholic Faith Community who

CGE1a -illustrates a basic understanding of the **saving story** of our Christian faith;
CGE1b -participates in the **sacramental life** of the church and demonstrates an understanding of the centrality of the Eucharist to our Catholic story;
CGE1c -actively reflects on **God's Word** as communicated through the Hebrew and Christian scriptures;
CGE1d -develops attitudes and values founded on Catholic **social teaching** and acts to promote social responsibility, human solidarity and the common good;
CGE1e -speaks the **language of life**... "recognizing that life is an unearned gift and that a person entrusted with life does not own it but that one is called to protect and cherish it." (Witnesses to Faith)
CGE1f -seeks intimacy with God and celebrates **communion** with God, others and creation through prayer and worship;
CGE1g -understands that one's purpose or **call in life** comes from God and strives to discern and live out this call throughout life's journey;
CGE1h -respects the **faith traditions**, world religions and the life-journeys **of all people of good will**;
CGE1i -integrates faith with life;
CGE1j -recognizes that "sin, human weakness, conflict and forgiveness are part of the human journey" and that the cross, the ultimate sign of forgiveness is at the heart of **redemption**. (Witnesses to Faith)

An Effective Communicator who
CGE2a -listens actively and critically to understand and learn in light of gospel values;
CGE2b -reads, understands and uses written materials effectively;
CGE2c -presents information and ideas clearly and honestly and with sensitivity to others;
CGE2d -writes and speaks fluently one or both of Canada's official languages;
CGE2e -uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life.

A Reflective and Creative Thinker who
CGE3a -recognizes there is more grace in our world than sin and that hope is essential in facing all challenges;
CGE3b -creates, adapts, evaluates new ideas in light of the common good;
CGE3c -thinks reflectively and creatively to evaluate situations and solve problems;
CGE3d -makes decisions in light of gospel values with an informed moral conscience;
CGE3e -adopts a holistic approach to life by integrating learning from various subject areas and experience;
CGE3f -examines, evaluates and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society.

A Self-Directed, Responsible, Life Long Learner who

CGE4a -demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;
CGE4b -demonstrates flexibility and adaptability;
CGE4c -takes initiative and demonstrates Christian leadership;
CGE4d -responds to, manages and constructively influences change in a discerning manner;
CGE4e -sets appropriate goals and priorities in school, work and personal life;
CGE4f -applies effective communication, decision-making, problem-solving, time and resource management skills;
CGE4g -examines and reflects on one's personal values, abilities and aspirations influencing life's choices and opportunities;
CGE4h -participates in leisure and fitness activities for a balanced and healthy lifestyle.

A Collaborative Contributor who

CGE5a -works effectively as an interdependent team member;
CGE5b -thinks critically about the meaning and purpose of work;
CGE5c -develops one's God-given potential and makes a meaningful contribution to society;
CGE5d -finds meaning, dignity, fulfillment and vocation in work which contributes to the common good;
CGE5e -respects the rights, responsibilities and contributions of self and others;
CGE5f -exercises Christian leadership in the achievement of individual and group goals;
CGE5g -achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others;
CGE5h -applies skills for employability, self-employment and entrepreneurship relative to Christian vocation.

A Caring Family Member who

CGE6a -relates to family members in a loving, compassionate and respectful manner;
CGE6b -recognizes human intimacy and sexuality as God given gifts, to be used as the creator intended;
CGE6c -values and honours the important role of the family in society;
CGE6d -values and nurtures opportunities for family prayer;
CGE6e -ministers to the family, school, parish, and wider community through service.

A Responsible Citizen who

CGE7a -acts morally and legally as a person formed in Catholic traditions;
CGE7b -accepts accountability for one's own actions;
CGE7c -seeks and grants forgiveness;
CGE7d -promotes the sacredness of life;
CGE7e -witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful and compassionate society;
CGE7f -respects and affirms the diversity and interdependence of the world's peoples and cultures;
CGE7g -respects and understands the history, cultural heritage and pluralism of today's contemporary society;
CGE7h -exercises the rights and responsibilities of Canadian citizenship;
CGE7i -respects the environment and uses resources wisely;
CGE7j -contributes to the common good.

Unit 1: Transportation Systems

Time: 35 hours

Unit Description

Students explore the vast array of land, marine, and aerospace transportation systems in use throughout the world. Students research systems and vehicles used in moving people and products, and identify design considerations including energy use and methods of power generation. Students analyse and compare various modes of transportation in terms of environmental and social impacts, both locally and globally.

Students examine design considerations related to moving people and goods, and issues related to infrastructure, human needs, economics and historical perspectives.

Unit Synopsis Chart

Activity	Time	Expectations	Assessment	Tasks
1.1 Research Project	240 min	TFV.03, TFV.04; TF2.01, TF2.02, TF2.03, TF2.04; ICV.04; IC1.01, IC1.02	Knowledge/ Understanding Thinking/ Inquiry Communication	Students research one topic within the scope of transportation systems and present findings.
1.2 Design a Better Transportation System	480 min	TFV.01, TFV.02; SPV.01, SPV.03, SPV.04; ICV.01; TF1.01, TF1.02; SP1.01, SP1.03; SP3.01; IC1.03; IC2.06	Knowledge/ Understanding Thinking/ Inquiry Application	Students use a design process to develop a plan for an improvement to the transportation system researched in Activity 1.
1.3 Build a Better Transportation System	1140 min	SPV.01, SPV.04; SP1.04, SP1.05; SP2.01	Knowledge/ Understanding Thinking/ Inquiry Application	Students construct a model of the system designed in Activity 2. Modifications to design are made as needed.
1.4 Presentation of Projects	240 min	TFV.02, TFV.03; SPV.03; TF1.01; SP1.06; SP3.01, SP3.05	Knowledge/ Understanding Thinking/ Inquiry Application Communication	Students prepare and deliver a class presentation on the model constructed in Activity 3. All available forms of media are considered.

Activity 1.1: Research Project

Time: 240 minutes

Description

Students employ a variety of methods and use multiple sources to research a chosen transportation system, with particular emphasis on the underlying technologies that allow the system to function, e.g., propulsion, guidance, support and control technologies. An emphasis is also placed on the environmental and social impacts of the chosen system as well as any recent technological developments that may have occurred. Students use the information gained during this activity to help complete activities throughout the unit.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Impact and Consequences

Overall Expectations

TFV.03 - identify the impact of the movement of people and goods on vehicle systems and modes of transportation (highway, rail, air, water, pipeline);
TFV.04 - describe the forms of energy used to power vehicles and transportation systems and explain the different types of energy conversion used for each;
ICV.04 - describe the post secondary and career opportunities available in the transportation sector following graduation from a college program.

Specific Expectations

TF2.01 - describe the importance of transportation systems to maintaining our quality of life;
TF2.02 - explain how people and goods are moved by highway, air, rail, water, and pipeline transportation systems;
TF2.03 - describe the importance of distance, weight, and volume when selecting the most cost-efficient means of transporting goods;
TF2.04 - explain how comfort and speed relate to the selection of the most cost-efficient means of transporting people;
IC1.01 - describe the consequences of transportation technology for individuals and for society;
IC1.02 - describe the possible impact of transportation technology on the environment.

Prior Knowledge & Skills

- Research skills
- Knowledge of how to work effectively with a partner
- Basic internet/keyboarding skills (preferred)

Planning Notes

- Arrange access to the school Library/Resource Centre and Internet access, if available.
- Review the school's policies and procedures for using the computer and the Internet.
- Develop a handout outlining the requirements of the assignment, including the marking scheme, due date and some Internet websites which can act as a starting point.
- Photocopy an outline of the schools policies and procedures regarding Internet and computer usage for distribution to students.
- Provide reference materials about transportation systems (texts, manuals, magazines, etc.).

Teaching/Learning Strategies

- The teacher introduces the topic by conducting a discussion of the Transportation Web. Specifically, the teacher reviews different types of transportation systems such as pipeline transportation, rail systems, or trucking systems. The teacher asks students what types of propulsion, guidance, support, and control technologies are associated with each form of transportation system. This discussion allows students to start thinking about the type of transportation system which they would like to investigate.
- Students form pairs and select a system that they would like to explore. Each pair is encouraged to pick a different system in order to increase the diversity of topic ideas.
- Students conduct in-depth research utilizing as many types of reference materials as possible, e.g., Internet sites, texts, manuals, magazines, personal interviews, etc.). Students are expected to evaluate the positive and negative social, environmental and economical impacts of the transportation system and form conclusions as to its effectiveness, identifying which parts of the system are effective and ineffective.

- Teachers should include references to land, water and air transportation.
- Each pair prepares a written assignment that satisfies all of the assignment's criteria. The students present their projects to the class and outline the social, economical, financial, and environmental impact that their chosen form of transportation has on society.

Assessment & Evaluation of Student Achievement

- Students' teamwork skills are assessed (see Appendix G – Sample Teamwork Checklist).
- The written report is assessed for content, quality, accuracy of information, originality of topic, research quality and diversity of sources, and bibliography and references.
- The oral presentation is assessed for quality of the presentation, understanding of the subject, and ability to answer student/teacher inquiries adequately (see Appendix C – Sample Checklist for Oral Presentations).

Accommodations

Some program modifications and strategies may include:

- the use of resource personnel to assist with the computer/internet;
- providing peer tutor assistance during research activities;
- accepting an oral report or multi-media presentation in lieu of the written report;
- providing additional time allowances;
- modifying the curriculum/project requirements as required;
- consulting with students, parents, and resource, guidance and special education departments to assist in creating an IEP for students;
- making modifications according to student's IEP.

Resources

Print

Carlson, D., Lisa Wormser, and Cyrus Ulberg. *At Roads End: Transportation and Land Use Choices for Communities*. Island Press, 1995. ISBN 1559633387

Forester, John. *Bicycle Transportation: A Handbook for Cycling Engineers*. MIT Press, 1994. ISBN 0262560798

Sperling, Daniel. *Future Drive: Electric Vehicles and Sustainable Transportation*. Island Press, 1995. ISBN 155963328X

Wells, Alexander T. *Air Transportation: A Management Perspective*. Broward Community College: Brooks/Cole, 1997. ISBN 0534534783

CD-ROM

Microsoft Encarta Encyclopaedia. CD-ROM. Microsoft #X03-52495

Websites

Society of Automotive Engineers - http://www.sae.org/index.htm
Transport Canada - http://www.tc.gc.ca

Videos

Several video tapes are available from:

The Learning Tree www.autovideo2000.com

ICS Learning www.icslearning.com

Activity 1.2: Design a Better Transportation System

Time: 480 minutes

Description

Students work in pairs to suggest improvements to the transportation system that they researched in Activity 1.1. Students decide which characteristics of the system are desirable, which are satisfactory, and which are undesirable. Using a design process model, students suggest improvements to the system and develop a plan to create a model.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Skills and Processes, Impact and Consequences

Overall Expectations

TFV.01 - apply the design process to develop solutions, products, processes, or services in response to challenges or problems in transportation technology;
TFV.02 - describe how materials and processes are used to produce solutions to meet human needs and wants related to transportation;
SPV.01 - design and produce models of different mass-transit systems that indicate the advantages and disadvantages of each system;
SPV.03 - use a variety of communication techniques to model and communicate product ideas, materials, and specifications;
SPV.04 - use mathematical and language skills and apply technological and scientific principles in the design, construction, and modification of vehicles and infrastructure for various modes of transportation;
ICV.01 - make informed decisions that take into consideration the social and environmental consequences related to the transportation sector.

Specific Expectations

TF1.01 - explain how human needs or wants related to transportation can be met through a new or improved vehicle or system;
TF1.02 - apply the following steps of the design process to solve a variety of transportation technology challenges or problems:

- identify what has to be accomplished (the problem);
- gather and record information, and establish a plan of procedures;
- brainstorm a list of as many solutions as possible;
- identify the resources required for each suggested solution, and compare each solution to the design criteria, refining and modifying it as required;
- evaluate the solutions (i.e., testing, modeling and documenting results) and choose the best one;
- produce presentation and working drawings, sketches, graphics, mathematical and physical models, or a prototype of the best solution;
- evaluate the prototype and determine the resources, including computer applications, required to produce it;
- communicate the solution, using one or more of the following: final drawings, graphs, charts, sketches, technical reports, electronic presentations, flow charts, mock-ups, models, prototypes, and so on;
- obtain feedback on the final solution and repeat the design process if necessary to refine or improve the solution;

SP1.01 - develop systems for production, marketing, personnel, and financial control related to transportation systems;
SP1.03 - sketch appropriate solutions to defined problems to scale showing orthographic and isometric views;

SP3.01 - interpret assembly drawings to identify and describe the components of a vehicle or a transportation system;
IC1.03 - identify a variety of materials, processes, and waste-management methods that would minimize the negative impact of a transportation-related activity;
IC2.06 - describe and evaluate the legislation pertinent to land, air and marine vehicles, as well as to working conditions and practices.

Prior Knowledge & Skills

- Understanding of the school and School Board policies and procedures regarding Internet and computer usage
- Research skills
- Knowledge of how to work effectively with a partner
- Basic Internet/keyboarding skills (preferred)

Planning Notes

Note: as this activity is linked to the previous activity in this unit, students must have completed the requirements for Activity 1.1 before beginning this activity.

- Prepare copies of Appendix I – Sample Design Process for distribution to the class.
- Arrange access to the school Library/Resource Centre and ensure that Internet access is available.
- Review the school and school board policies and procedures for the computers and using the Internet.

Teaching/Learning Strategies

- The teacher and students discuss environmental, societal, ergonomic, and financial impacts that mass transportation systems may cause. For example, pipelines can cause environmental disasters, affect native wildlife, and necessitate the need to purchase large amounts of land. Also, they are often located in areas that can be difficult to access in the event of an emergency.
- Students determine and list any impacts that their particular transportation system may cause.
- Students are given Appendix I – A Sample Design Process.
- Students implement the design process model (see Appendix I – A Sample Design Process) in order to brainstorm possible solutions to some or all of the problems listed. From this list they determine three possible solutions.
- Students submit a proposal of possible solutions and their rationale.
- After receiving teacher approval, the students conduct in-depth research about the viability of their solutions utilizing as many types of reference materials as possible, e.g., Internet sites, texts, manuals, magazines, personal interviews, etc. Once the most likely solution(s) is/are chosen, students outline and evaluate the effectiveness of their system using the following criteria:
    - how effectively does it solve the design problem?
    - how environmentally friendly is the new system?
    - how ergonomically suitable is the new system?
    - how efficient is the new system?
    - does the new system appear to be cost effective?
    - what type of societal impact, if any, will occur from the implementation of the new mass transportation system?

- Students present their solutions to the class and defend the proposed changes to their transportation system.
- Taking into consideration the opinions expressed by their peers and instructor, the students modify their transportation system.
- The students prepare a plan to implement their design in a model. The plan must include:
  - detailed sketches;
  - a materials list;
  - an estimate of cost and source of materials for the model;
  - an implementation plan for construction.

Assessment & Evaluation of Student Achievement

- The teacher assesses the viability of the proposed changes in reference to cost, time, the environment, and societal impact.
- Students' research is assessed for quality and diversity, and bibliography and references.
- The written report is assessed for content, quality, accuracy of information, and originality of design solution.
- The oral presentation is assessed for quality of presentation, understanding of subject and ability to defend the proposed changes to the transportation model (see Appendix C – Sample Checklist for Oral Presentations).
- A project assessment and critique is done by self, peers, and the teacher (see Appendix – G Sample Teamwork Checklist).

Accommodations

Some program modifications and strategies may include:

- the use of resource personnel to assist with the computer/Internet;
- permitting an oral report or multi-media presentation in lieu of a written report;
- waiving the oral presentation in favour of an alternative assignment.

Resources

Print

Carlson, D., Lisa Wormser, and Cyrus Ulberg. *At Roads End: Transportation and Land Use Choices for Communities*. Island Press, 1995. ISBN 1559633387

Forester, John. *Bicycle Transportation: A Handbook for Cycling Engineers*. MIT Press, 1994. ISBN 0262560798

Sperling, Daniel. *Future Drive: Electric Vehicles and Sustainable Transportation*. Island Press, 1995. ISBN 155963328X

Wells, Alexander T. *Air Transportation: A Management Perspective*. Broward Community College: Brooks/Cole, 1997. ISBN 0534534783

Websites

American Public Transportation Association - http://www.apta.com/

Transportation Research: The University of Leeds - http://www1.leeds.ac.uk/~yimling

Inductrac - http://www.llnl.gov/str/Post.html

Project California - http://merkury.saic.com/calif/maglev.html

The Subway Page - http://www.reed.edu/~reyn/transport.html

CD-ROM

Microsoft Encarta Encyclopaedia. CD-ROM. Microsoft

Activity 1.3: Build a Better Mass Transportation System

Time: 1140 minutes

Description

Students develop knowledge and skills in the areas of design-modification and construction process by building an interactive model of their improved transportation system. This activity directly addresses the expectations identified for this unit by requiring students to:

- understand the operations of a mass transportation system;
- implement the previously-improved transportation system into an interactive model;
- describe and practise safe and appropriate work habits throughout the design and construction process.
- Students develop thinking and problem-solving skills throughout the design-modification and building process.

Strand(s) & Learning Expectations

Strand(s): Skills and Processes

Overall Expectations

SPV.01 - design and produce models of different mass-transit systems that indicate the advantages and disadvantages of each system;
SPV.04 - use mathematical and language skills and apply technological and scientific principles in the design, construction, and modification of vehicles and infrastructure for various modes of transportation.

Specific Expectations

SP1.04 - use fabrication techniques to mock up or model potential solutions to a transportation technology challenge;
SP1.05 - test materials and products to develop the best solution to a transportation technology challenge;
SP2.01 - select and use a wide variety of hand and machine tool procedures to repair, service, fabricate, and modify a vehicle or a transportation system.

Prior Knowledge & Skills

- Fundamental understanding of a mass transportation system
- Familiarity with basic model building techniques
- Ability to work effectively in a group setting

Planning Notes

Note: as this activity is linked to the previous activities in this unit, students must have completed the requirements for Activities 1.1 and 1.2 before beginning this activity.

- Obtain a project completed by a student from a previous class as a demonstration aid.
- Obtain some building materials for students to use at the start the project.

Note: the use of a range of materials provides greater learning opportunities for processes such as cutting, shaping, forming, and joining. However this may require more time than the teacher has assigned to this design challenge. To limit the scope and time of the challenge the teacher may constrain the solutions to specific materials, e.g., wood and plastic.

Teaching/Learning Strategies

- The teacher discusses the transportation system design challenge, i.e., to design and manufacture a model of a transportation system and provides information regarding the context of the challenge, i.e., the time frame, the equipment, and materials available. The teacher provides samples of models, i.e., demonstration aids created by the teacher or models completed by former students and discusses the features of these models with the students.
- Students are divided into groups of two. Each group determines what type of improved transportation system they will research and construct. Project constraints such as time, materials, and prior expertise are discussed, and students record these in their notes.
- Students create paper or cardboard models and sketches to determine the appropriate shape for their model. Each group is encouraged to pursue their own design ideas in their selection of the shape, materials, and overall functioning of their transportation system. The teacher instructs students on the proper use of hand tools required for modelling, e.g., utility knife, safety ruler, hot glue gun, drafting instruments, etc.
- Before beginning to build a more permanent structure, each group must obtain teacher approval of their temporary model.
- The teacher instructs on the process skills required to create a high finished model and demonstrates the safe use of equipment that students will use during construction. The teacher assists students in process choices without limiting innovative attempts.
- The teacher and students discuss material conservation. Students must consider cutting allowances to minimize wastage. The teacher furthers students' understanding of this concept by discussing the fact that design is driven by available resources, especially when mass production is anticipated and the cost of waste becomes considerable. Students are asked to recycle materials from home into their projects if possible rather than use new materials.
- Students are encouraged to use patterns and templates whenever possible. The teacher instructs students to use the first cut piece as the pattern for all other identical pieces, rather than measuring each piece individually (creating unwanted variance in the pieces).
- The teacher instructs and demonstrates the safe use of each new process, machine, or tool. Students must not be allowed to use potentially dangerous equipment, notably power tools, without prior instruction on the safe and correct use of each tool. Students' readiness to operate the various tools permitted for this activity must be determined through the use of the Safety Passport model (see Appendix J – Sample Safety Passport).
- The teacher encourages self-directed learning, e.g., the teacher suggests text research when students ask process questions.
- Students maintain a journal or logbook of activities (see Appendix A – Student's Weekly Log Sheet and Appendix B – Daily Checklist of Student Activities) to record evidence of their learning.
- Students complete the project and produce a detailed, written report of the sequential steps used and all modifications made as part of their design report.
- Students assess their project and their design report to ensure they considered the design challenge criteria and all components of the design report. The design report is based on daily journal notes and must contain:
    - the context and design criteria;
    - preliminary sketches and ideas;
    - steps in producing the product;
    - a 3-D sketch or drawing of the final product;
    - reflection on the process and product.
- The final project and design report are presented by students to peers, teachers and if applicable, to clients.

Assessment & Evaluation of Student Achievement

- Log books are completed daily by students providing students an opportunity to demonstrate knowledge acquired and note daily participation and achievements (see Appendix A – Student's Weekly Log Sheet).
- A checklist of student activities is completed daily by the teacher, and tracks student performance in the shop (see Appendix B – Daily Checklist of Student Activities).
- The completed project is assessed for the quality of the finished product and for the constructions process (see Appendix K – Sample Transportation System Design Rubric).

Accommodations

Some program modifications and strategies may include:

- providing peer tutor assistance while using power tools;
- providing additional time allowances for welding or machining, if required;
- modifying the curriculum/project requirements as required;
- consulting with students, parents, and resource, guidance and special education departments to assist in creating an IEP for students.

Resources

Print

Daiber, Robert and Thomas L. Erekson. *Manufacturing Technology Today and Tomorrow*. United States: Glencoe/McGraw-Hill Educational Division, 1991. ISBN 0-02-675751-6

Giachino, J.W., William Weeks, and Elmer Brune. *Welding Skills and Practices,* 4th ed. United States: American Technology Society, 1974. ISBN 0-8269-3042-5

Komacek, Stanley, Anne Lawson, and Andrew C. Horton. *Manufacturing Technology*. United States: Delmar Publishers Inc., 1990. ISBN 0-8273-3462-1

Krar, S.F. and J.W. Oswald. *Technology of Machine Tools,* 3rd ed. United States: McGraw-Hill Ryerson, 1987. ISBN 0-07-549025

Activity 1.4: Presentation of Projects

Time: 240 minutes

Description

Students develop knowledge and skills in effective communication. Using a variety of media, students create a class presentation of their transportation model. This activity directly addresses the expectations identified for this unit by requiring students to:

- produce a presentation for the class utilizing various methods of communication technology;
- describe to the class the operations of a mass transportation system before their improvements;
- present to the class their improved transportation system and interactive model;
- describe to the class why this form of transportation is feasible in terms of comfort, efficiency, cost, and environmental/societal impacts;
- present to the class a list of careers available and the future of their transportation system.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Skills and Processes

Overall Expectations

TFV.02 - describe how materials and processes are used to produce solutions to meet human needs and wants related to transportation;
TFV.03 - identify the impact of the movement of people and goods on vehicle systems and modes of transportation (highway, rail, air, water pipeline);
SPV.03 - use a variety of communication techniques to model and communicate product ideas, materials, and specifications.

Specific Expectations

TF1.01 - explain how human needs or wants related to transportation can be met through a new or improved vehicle or system;
SP1.06 - select and use appropriate software to develop marketing strategies for a solution to a transportation technology challenge;
SP3.01 - interpret assembly drawings to identify and describe the components of a vehicle or a transportation system;
SP3.05 - prepare and present effective oral reports about a product or process.

Prior Knowledge & Skills

- Fundamental understanding of a mass transportation system
- Completed model of an improved transportation system from Activity 1.3 to be used in a presentation

Planning Notes

- Provide several forms of media equipment, such as computers, video cameras, digital cameras, a scanner, an overhead projector, and access to a photocopier.
- If the teacher is unfamiliar with the types of media to be used, invite a resource person who is familiar with the various equipment to assist during class time.
- Prepare a presentation on the airport model example used in Activity 1.3 – Build a Better Transportation System for demonstration purposes.

Teaching/Learning Strategies

- The teacher introduces the activity by leading a class discussion on various methods of presenting the projects constructed in Activity 1.3. A teacher-made presentation provides an example of the type of work required.
- Students are instructed to create a presentation that includes information about all aspects of the process followed to complete the project, as well as information about careers opportunities (current and projected) related to the transportation field on which their project is based.
- Short, introductory lessons and practice sessions in the use of available media are provided to all students.
- Students complete their presentations utilizing appropriate media. The teacher acts as a facilitator, assisting groups with technical problems and guiding development of the presentation.
- Each group presents their work to the class and an opportunity for questions is provided.

Assessment & Evaluation of Student Achievement

- The completed presentation is marked for presentation style and effectiveness (see Appendix L - Sample Assessment Rubric for Transportation System Presentation Project).
- Log books are completed daily by students providing students an opportunity to demonstrate knowledge acquired and note daily participation and achievements (see Appendix A – Student's Weekly Log Sheet).
- A checklist of student activities is completed daily by the teacher, and tracks student performance in the shop (see Appendix B – Daily Checklist of Student Activities).

Accommodations

Some program modifications and strategies may include:

- the use of resource personnel to assist with media equipment;
- providing extra practise time with media equipment;
- permitting a videotaped presentation;
- waiving the oral presentation in favour of an alternative assignment;
- consulting with students, parents, and resource, guidance and special education departments to assist in creating an IEP for students.

Resources

Presentation software such as Corel Presentation or Microsoft Power Point

Video editing equipment or software such as Avid Cinema.

Websites

Microsoft Office Update Page - http://officeupdate.microsoft.com/articlelist/o2kPowerPointArticles.htm

Provides "How to" and "Tricks and Tips" articles for using Microsoft Power Point software.

Presentations. Com - http://www.presentations.com/

Provides several links on strategies for a good presentation and information on software applications.

Appendix A

Student's Weekly Log Sheet

Student's Weekly Log Sheet
This page is to be completed daily, detailing the activities in which you have been involved. Your entries will be used as an aid in determining a Practical Performance mark. Include any information you would like your teacher to know when calculating this mark. This page must be handed in each week.

Name: _____ Class: _____ (Monday) Date: _____
On Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑
Description of Activities: _____
_____
_____
_____

(Tuesday) Date:_____
On Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑
Description of Activities: _____
_____
_____
_____

(Wednesday) Date: _____
On Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑
Description of Activities: _____
_____
_____
_____

(Thursday) Date: _____
On Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑
Description of Activities: _____
_____
_____
_____

(Friday) Date: _____
On Time? ❑ Prepared? (book, etc,) ❑ Participation (1-10) ❑
Description of Activities: _____
_____
_____
_____

Appendix B

Daily Checklist of Student Activities

Class:											**Date:**
Student	Present	On-time	Prepared	On-task	Use of Resource	Safe Work Practices	Evidence of Problem Solving	Correct Procedures	Correct Use of Equipment		Comments

Additional Comments:

Appendix C

Sample Checklist for Oral Presentations

Criteria	Yes	No
Voice – speaker's voice was clear and easy to hear		
Eye Contact – eye contact was made with members of audience		
Focus – presenters stayed on topic		
Content of presentations – presentation contained a clear opening and closing statement		
Ideas were logically developed throughout the presentation		
Presenter clearly communicated the stages of the design process		
Presentation engaged audience		

Appendix G

Sample Teamwork Checklist

Teamwork Checklist of Behaviour	Check if attained
Responds to and is sensitive to the needs and welfare of others.	
Solves problems collaboratively.	
Takes responsibility for an appropriate amount of the work to be done.	
Works to help achieve the goals of the group or class.	
Motivates others by encouraging them to participate.	
Contributes information and ideas to solve problems and make decisions.	
Questions the ideas of the group to seek clarifications, test thinking or reach agreement.	
Shows respect for the ideas and opinion of others in the group or class.	
During discussions, paraphrases points of view and asks questions to clarify meaning.	
Recognizes the contribution of other group members through the use of encouragement, support, or praise.	
Seeks consensus and negotiates agreement before making decisions.	

Appendix I

Sample Design Process

Open Ended Problem Solving and the Design Process
Design is the act of inventing and innovating new products or services to satisfy needs or a change in needs. Design is a creative problem-solving activity. Like most creative processes, there are no correct procedures but there are guidelines that assist the designer in ensuring that the optimal solution is met. These guidelines are called the design process.

At the beginning of the design process, students analyse a given set of conditions in order to identify a technological problem, challenge, or need. Students then work through a number of stages in order to arrive at a solution. Design processes include all stages in the development of a product. Although the design process may have distinctive stages, they are not followed in a rigid, step-by-step sequence. For example, students must evaluate their work at each stage of the process. As they do so, students may discover that they need to return to an earlier stage to make modifications or to complete a particular step sooner than originally planned. A portfolio and/or a design report is used to document the design process.

Identification and Clarification of a Technological Problem
Students identify the technological problem and begin keeping a record of the design process. Students initially outline the broad aims of the project and describe in a general way what needs to be done to achieve those aims. Students may periodically revise the initial broad plan to reflect what is actually happening. Students need to translate the information given to them by the teacher into the sub-stages below. This provides an understanding of each sub-stage so students can independently complete the stage in later grades. Possible sub-stages for the design report are:

- context;
- problem situation;
- technological problem statement;
- performance specifications and constraints;
- planned sources of information.

Generation of Multiple Solutions
Students identify possible solutions for the technological problem and the resources required to achieve each proposed solution. Students determine the availability of required resources and record their findings. During this stage students may discover that they need to redefine the problem. Possible sub-stages for the design report include:

- brainstorming to generate ideas/solutions for the technological problem;
- selecting several ideas from the solutions generated in the brainstorming exercise (typically three);
- drawing rough sketches for these ideas;
- completing an analysis for each idea (i.e., indicating details on the rough sketches);
- identifying the materials and tools needed for each idea;
- making scale models of technological problem ideas to work out initial details of complexity and feasibility (scale models are not always required - they are used only if they help to clarify ideas).

Appendix I (Continued)

Selection of a Best Solution
Students establish the evaluation criteria for the selection of a best solution. They consider such factors as: what materials, tool, and resources are available; the amount of time needed to carry out difficult procedures; and any relevant ergonomic and aesthetic requirements. Students choose the best solutions based on the results of these activities. They record the reasons for choosing a particular solution.

Possible sub-stages for the design report include:

- establishing evaluation criteria for the best solution based on performance specifications, constraints, attribute analysis (details from rough sketches of ideas), and available materials;
- evaluating ideas according to the established evaluation criteria for the best solution by creating a chart to rate each idea;
- creating a working drawing of the idea selected as the best solution.

Production Plan
Students determine ways of producing the best solution and then construct a prototype of the product. Students produce a model-sized prototype using production-type materials, where possible. Students first draft a revised or working drawing and develop a production plan. Students may modify their best solution while moving through the production phase to incorporate ideas that emerge during construction. Students document all such changes. Possible sub-stages for the design report include:

- creating drawings of the selected ideas;
- calculating the materials needed to produce the selected idea and the associated costs;
- ordering supplies for the project;
- developing a critical path, and incorporating key dates;
- completing the project, and producing (in detail) the sequential steps used and all modifications made.

Project and Process Evaluation
Students evaluate their project and their design report. They consider their own expectations and criteria and the reactions of their peers, teachers and, if applicable, their client.

Present the Results
The final project and design reports are presented to communicate the results.
This design process is adapted from the work of Dr. Ann Marie Hill, Queens University.

Appendix J

Sample Safety Passport

This is a sample of a generic safety passport that may be adopted for use in a number of technology classrooms. The purpose of the safety passport is to ensure that students are fully aware of all safety features on each piece of equipment in the technical facility prior to using it independently. This process may be adapted to suit the needs of the teacher and students.

The general process is as follows:

1. Students record the date of the safety demonstration on the safety passport. It is initialled by the teacher (see sample below) when a new piece of equipment, e.g., the lathe, is introduced. The teacher demonstrates techniques for the safe operation of the machine and personal protective equipment (e.g., wearing proper eye protection, securing loose hair, removing jewellery, wearing protective clothing, etc.). Students take notes of the demonstration and record the information in a notebook along with the signed passport slip. If a student is absent on the day of a safety demonstration, a makeup opportunity must be provided.
2. Each student must complete a written (or oral) test on the safe operation of the machine tool, outlining all safety features that must be observed. Students must record the written tests in a notebook. These individual machine tests are designed to complement any general facility safety rules. Students date the "tested" column and the teacher initials this as complete when the test is completed satisfactorily. Next, students must demonstrate to the teacher that they have a thorough knowledge of the safety rules for the equipment and are able to demonstrate their competency on the equipment. Once the teacher has observed the required safe setup and operation of the equipment by a student, the teacher signs off that portion of their passport.
3. The teacher signs the final column of students' safety passport once students have completed steps 1, 2, and 3. Students are now able to use that piece of equipment. Students must be able to provide the teacher with their signed passport for that equipment each time they wish to use it. A summary document of all the various permissions may be created by students and signed by the teacher (as permissions are earned). These summary safety passports may be protected with page protectors or laminated for protection. See the sample summary passport below.

Sample Equipment Safety Passport

Student Name: _____

Equipment: _____

See notebook for the note on safe set-up and operation of the equipment.

Attended Teacher Safety Instruction and Demonstration (and note recorded)		Passed Written or Oral Testing		Demonstrated Safe Set-up and Operation of Equipment to Teacher		Granted Permission to use Equipment by Teacher	
Date of Lesson	Teacher Initial	Date Tested	Teacher Initial	Date of Demo	Teacher Initial	Date	Teacher Initial

Appendix K

Sample Transportation System Design Rubric

Criteria	Level 1 (50–59%)	Level 2 (60–69%)	Level 3 (70–79%)	Level 4 (80–100 %)
Knowledge/ Understanding Project Requirements SPV.01; SP1.05	- demonstrates limited knowledge of project requirements	- demonstrates some knowledge of project requirements	- demonstrates considerable knowledge of project requirements	- demonstrates thorough knowledge of project requirements
Thinking/Inquiry Design SPV.04	- applies few of the skills involved in a design process	- applies some of the skills involved in a design process	- applies most of the skills involved in a design process	- applies all or almost all of the skills involved in a design process
Application Model Building SP2.01	- uses procedures, equipments, and technology safely and correctly only with supervision	- uses procedures, equipments, and technology safely and correctly with some supervision	- uses procedures, equipments, and technology safely and correctly	- demonstrates and promotes the safe and correct use of procedures, equipments, and technology

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Appendix L

Sample Assessment Rubric for Transportation System Presentation Project

Expectations	Level 1 (50–59%)	Level 2 (60–69%)	Level 3 (70–79%)	Level 4 (80–100%)
Prepare a presentation to demonstrate the transportation model to the class. TFV.02, TFV.03; SPV.03; TF1.01; SP1.06; SP3.05	- presentation includes key points of information - at least one form of presentation media used, e.g., overhead projector	- presentation includes a partial rationale for the model and overview of the process followed - more than one form of presentation media used	- presentation includes a complete rationale for the model and overview of the process followed - a variety of forms of presentation media used	- presentation includes scientific or technical information supporting its development - presentation media used is the best available to the student, e.g., use of computers and video

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Unit 4: Vehicle Systems Design

Time: 40 hours

Description

In this culminating unit, students apply their knowledge and skills in developing a model or prototype vehicle system to solve specific problems in transporting goods or people. Vehicle designs may be related to aerospace, land, or marine systems studied in Unit 1, testing devices, used in Unit 2 and/or incorporate power systems studied in Unit 3. Project selection may be drawn from vehicle components or systems as found in concept cars or motor-sport, replacement or after-market accessories, testing devices or special use modifications such as those developed for the handicapped. In developing vehicle systems (or improving existing ones), students consider such parameters as economic, environmental, and production methods, as well as design parameters such as ergonomics, efficiency, aerodynamics, and mechanical engineering concepts. Students reflect and create meaningful solutions using a holistic approach to problem solving and decision making with an informed conscience and a goal to work towards the common good.

Unit Synopsis Chart

Activity	Time	Expectations	Assessment	Tasks
4.1 Designing Vehicle Systems	1200 min	TVF.01, TVF.02; TF1.01; TFI.02; SPV.03, SPV.04; SP1.02, SP1.03, SP1.04, SP1.05; ICV.01, ICV.02; IC1.02; IC2.01 CGE2c; CGE3e, CGE3f; CGE4a, CGE4b, CGE4c	Knowledge Inquiry Communication Application	Examine design criteria and develop ideas to solve prescribed design problem. Examine pictorial drawings and several drawing methods to create plans, calculate dimensions and draw various sections of the vehicle to scale. Examine fabrication concepts, aerodynamics, aesthetics, and engineering testing.
4.2 Implementing Vehicle Design Ideas	1200 min	TFV.01, TFV.02, TFV.03; TF1.01, TF1.02; SPV.03, SPV.04; SP1.04, SP1.05; SP2.01, P2.02; SP3.01, SP3.05; SP4.02; ICV.02 CGE3f; CGE5f, CGE5g	Knowledge Inquiry Communication Application	Completion of design solution, testing, and presenting

Activity 4.1: Designing Vehicle Systems

Time: 1200 minutes

Description

Students design and build engineered solutions to challenges in transportation vehicles. Students generate ideas through sketching, modelling, testing, and technical drawing techniques. Students examine vehicle design evolution, concepts in aerodynamics, aesthetics, and ergonomics. To develop their ideas, students build models and prototypes, produce pictorial and orthographic drawings, and test components and systems. Students demonstrate consideration of others and take initiative to demonstrate Christian stewardship of the environment and of the workplace.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Skills and Processes, and Impact and Consequences

Theory and Foundation

Overall Expectations

TFV.01 - apply the design process to develop solutions, products, processes, or services in response to challenges or problems in transportation technology;
TFV.02 - describe how materials and processes are used to produce solutions to meet human needs and wants related to transportation;

Specific Expectations

TF1.01 - explain how human needs or wants related to transportation can be met through a new or improved vehicle or system;
TF1.02 - apply the following steps of the design process to solve a variety of transportation technology challenges or problems:

- identify what has to be accomplished (the problem);
- gather and record information, and establish a plan of procedures;
- brainstorm a list of as many solutions as possible;
- identify the resources required for each suggested solution, and compare each solution to the design criteria, refining and modifying it as required;
- evaluate the solutions (e.g., by testing, modeling, and documenting results) and choose the best one;
- produce presentation and working drawings, sketches, graphics, mathematical and physical models, or a prototype of the best solution;
- evaluate the prototype and determine the resources, including computer applications, required to produce it;
- communicate the solution, using one or more of the following: final drawings, graphs, charts, sketches, technical reports, electronic presentations, flow charts, mock-ups, models, prototypes, and so on;
- obtain feedback on the final solution and repeat the design process if necessary to refine or improve the solution.

Skills and Processes

Overall Expectations

SPV.03 - use a variety of communication techniques to model and communicate product ideas, materials, and specifications;
SPV.04 - use mathematical and language skills and apply technological and scientific principles in the design, construction, and modification of vehicles and infrastructure for various modes of transportation.

Specific Expectations
SP1.02 - use computers to help develop, operate, and control transportation systems;
SP1.03 - sketch appropriate solutions to defined problems to scale showing orthographic and isometric views;
SP1.04 - use fabrication techniques to mock up or model potential solutions to a transportation technology challenge;
SP1.05 - test materials and products to develop the best solution to a transportation technology challenge.

Impact and Consequences

Overall Expectations
ICV.01 - make informed decisions that take into consideration the social and environmental consequences related to the transportation sector;
ICV.02 - describe, and apply where appropriate, the exemplary practices that are essential to safe work environments and practices.

Specific Expectations
IC1.02 - describe the possible impact of transportation technology on the environment;
IC2.01 - apply safe work practices when performing transportation-related processes.

Ontario Catholic School Graduation Expectations
CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;
CGE3e - adopts a holistic approach to life by integrating learning from various subject areas and experience;
CGE3f - examines, evaluates, and applies knowledge of interdependent systems (physical, political, ethical, socio-economic, and ecological) for the development of a just and compassionate society;
CGE4a - demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;
CGE4b - demonstrates flexibility and adaptability;
CGE4c - takes initiative and demonstrates Christian leadership.

Prior Knowledge & Skills

- A basic understanding of research techniques, basic steps in the design process, and a general understanding of the rules and safety requirements of the technical facility acquired from the previous chapters.
- Teachers should review basic concepts, particularly safety standards, before initiating, and throughout the activity.

Planning Notes

The important aspects of this activity are:

- Design and develop solutions by examining systems, such as control, propulsion, powertrains, aerodynamics, and ergonomics, or transportation systems such as rail, marine shipping, trucking, etc.
- Develop solutions to prescribed transportation problems by applying a step-by-step prototyping procedure.
- Develop solutions by applying fabrication, modeling and drawings techniques.
- Develop an understanding of material properties and modeling processes.
- Identify environmental issues related to the activity (issues such as improvement of fuel consumption, improvement of efficiency of transportation systems, etc.)

- Teachers pre-select a design situation, ideally based on previous work in the course. The situation and final products can take many forms, including:
  - full-scale alternative power vehicle (human powered, electric vehicles)
  - radio controlled scale model vehicles (airplanes, blimps, boats, land vehicles)
  - full-scale systems re-design (auto, marine, aerodynamic styling alterations, power transmission systems [gears, sprockets, belts, etc.])
  - testing devices or service equipment (ATV ramp hoist/trailer)
- Typical projects may include an electric powered vehicle for a competition (e.g., Queens Electric Car Race, EVCO race), radio control boats or airplanes to test concepts in aerodynamics, or go-carts altered to test concepts in power transmission, braking, suspensions, or fuel types. An important aspect of any project is to give students the opportunity to engineer solutions to transportation vehicle problems or situations.
- In this activity, students develop models, test models, plans and drawings to create a vehicle based on provided criteria. The focus of the activities in this unit should be to encourage working models or prototypes, and to engage students in developing mechanisms for control, power, and suspension.
- Teachers may elect to either present the project as a competition among design groups, or separate students into different design teams to cover aspects of one or more vehicles such as steering, motive power systems, controls, aerodynamics, etc. Teachers are to ensure each student produces their own sketches, and drawings, and participates fully in model production. Each student will sketch orthographic drawings, supplying top, side, and/or front view as required. Students should log their daily hours on the project for later assessment/evaluation or review.
- Teachers could prepare materials for drawing and modelling such as:
  - sketching paper, pens, pencils, scales, rulers
  - welding rods, brazing and welding equipment (to model frames, if required)
  - cardboard, stiff paper, plastic sheets, sheet metal, tape, and modelling clay for body styling
  - wheels, steering mechanisms, motors, radio control equipment, etc., as required.
- Teachers should also bring in articles about current issues related to transportation, (from magazines or websites such as Popular Science or Popular Mechanics, newspapers, etc.) for class discussion.

Teaching/Learning Strategies

Stage 1: Introduction to Current Design Trends

The teacher introduces the activity by leading a class discussion on recent changes in vehicle design, based on systems examined in previous units. Teachers should direct discussions to recent developments in body materials (e.g., plastics, magnesium, the new steel), motive power (e.g., Ballard hydrogen cells), safety (e.g., brakes, handling, passenger elements), or environmental issues (e.g., fuel consumption, trends in SUVs, alternate power vehicles). Students are directed to examine how their upcoming design work will incorporate concepts that improve environmental conditions, social conditions, (e.g., affordable transportation), and/or safety issues. Students are asked to brainstorm issues by listing them on the board or chart paper, and to duplicate the list in their notebooks. This list is kept in the classroom for reference throughout the project.

Stage 2: Idea Production

Teachers then focus discussion on the selected vehicle design project. Teachers outline criteria and present a design brief. Students are divided into design groups and given specific tasks to develop and build a vehicle based on criteria presented. Students are reminded of their duties as Christians to ensure fair play, respect for their fellow workers, and respect for the environment.

Teachers discuss the elements of a design and product development procedure that students will use to develop their solutions (See Appendix 4-1A – The Prototype Design and Development Process).

Students are given handouts to encourage and direct their efforts (see Appendices 4-1B to 4-1G). Students are given the task individually to develop a proposal of ideas, including a suggested list of team members and responsibilities, suggested procedures, considerations for environmental and/or social issues (such as noise, fuel consumption, respect for nature, etc.), and their plan of action. Students generate ideas through preliminary research and brainstorming through sketching ideas. Students are given the opportunity to explore ideas by fabricating simple models or test models. Proposals are discussed individually or with the team before members proceed to the next step.

Students are to initiate a Design Journal to record their design procedures, their daily log of activities, and testing results.

Stage 3: Modelling Ideas

The teacher introduces the next phase of the activity by leading a class discussion on prototype design and modelling techniques. (**Note:** prototyping and modelling design is accomplished through physical fabrication and testing using simple and cheap materials. This technique is most appropriate since drawing, scaling, and calculating dimensions or mechanisms is difficult without first visualizing 3D models.) Teachers demonstrate fabrication techniques such as welding, cutting, bending, joinery, etc., for specific materials such as wood, metal, plastics, and fabric as required, to give students ideas for possible models and project solutions.

Students form into their design groups to discuss their plan of action with the teacher. Teachers approve plans before students begin modelling fabrication.

Teachers reinforce specific safety instructions before students begin modelling fabrication. Students fabricate prototypes, models, and test models to verify the operation of systems, e.g., steering mechanisms, as they are required to prove their solutions.

Stage 4: Drawing Ideas

Teachers introduce the concept of developing drawings for the manufacture or fabrication of the design solutions. Teachers introduce appropriate computer programs and/or drawing instruments to produce sketched orthogonal views, then to produce finished drawings. Teachers discuss scale, drawing techniques, and measurement. Teachers discuss the basic concepts in orthogonal and isometric drawings.

Students, on an individual basis, produce finished scaled drawings of their designs for assessment and evaluation. (**Note:** even though designs were developed and tested as a group, each student is required to produce their own set of drawings.)

Teachers discuss, in a class situation, solutions with each design group. Each group describes their solutions, the problems they encountered, and the rationale behind their design decisions.

Assessment & Evaluation of Student Achievement

It is important that teachers distribute assessment/evaluation rubrics at the initiation of the activity to guide students' development and to direct their efforts (See Appendix 4-1F- Vehicle System Design Evaluation Rubric). Students are evaluated on demonstrated knowledge of the design and product development process, modeling and testing, through sketches and/or models, accuracy of scale/measurements, and presentation of rationalization of ideas. The tools to use for assessment and evaluation include the Design Brief, models and prototypes, fabrication drawings, presentation of solutions, and daily observation of safe working habits and effort.

Accommodations

Various accommodations may be made throughout the program to assist students with special needs. Possible program accommodations may include ensuring availability of accessible equipment and tools, enlarged print, and extra handouts and research materials. Other accommodations may include extra teacher-student conferencing, teacher-student-parent conferencing, small group learning, peer tutoring, and the use of a buddy system.

Opportunities for enrichment may include requirements for cost analysis, research reports on material properties as related to the project, or requiring detailed computer-generated drawings such as 3D modelling.

Resources

(**Note:** use search terms related to specific project in search engine or catalogue sites)

Scotty's Centre for Technology Education, (Scotty's Design Shack, on design teaching
- http://www.millenniumwave.com

Engine Design
- http://www.aera.org/main.htm

Inner Auto
- www.innerauto.com

Popular Mechanics Magazine
- http://www.popularmechanics.com/

Society of Automotive Engineers
- http://www.sae.org/index.htm

Print Resources

Stirling, Norman. *Introduction To Technical Drawings*. Gage Publishing Limited, 1980. ISBN 0-7715-0326-1

Erjavec, Jack. *Automotive Technology. A Systems Approach*, 3rd ed. Delmar Thompson Learning, 2000. ISBN 0-7668-0673-1

Crouse. W., D. Anglin, and W. Crouse. *Automotive Mechanics*. Glencoe McGraw-Hill, 1993. ISBN 0028009436

Schwaller, Anthony E. *Transportation Energy and Power Technology*. Glencoe McGraw-Hill. ISBN 0-8273-3227-0

Bamsey, I. *The Anatomy and Development of the Sports Prototype Racing Car*. England: Haynes Publishing, 1991. ISBN 0-87938-586-3

Other

Ministry of Transportation Emission Laws

Ontario Health and Safety Act

Oxy-acetylene welding textbooks and MIG welding textbooks

Telephone directories

Industrial directories

Teachers should consult with teachers from other schools on project possibilities and for arranging local competitions. The Internet has many examples of competitions that can be used to determine strategy.

Competitions

EVCO Electrathon
- www.igs.net/~darrylmcmahon/otthon99.html

Queen's University Electric Car Race
educ.queensu.ca/~techstd/gecr1999.htm

Skills Canada
- www.skillscanada.ca

Appendix 4-1A

The Prototype Design and Development Process

Back of the Envelope Design

Define the situation or problem to be addressed.

Describe the "Big Issues" criteria that needs to be addressed (e.g., cost, materials, timeframes, client and/or user needs).

Develop and suggest a solution for testing the Prime Generator.

Model and test the solution.

Describe other criterion that is discovered through modelling and testing, e.g., fabrication/fitting problems, structural problems, etc.

Redefine and modify the solution, and re-test as required.

Define dimensions, components, and fabrication details based on completed testing.

Complete the drawings for the fabrication of the solution.

Fabricate, and adapt the solution as required, and modify the solution and drawings as required.

Develop a report and analyse how improvements can be made in further work.

(adapted from the work of Michael Scott, millenniumWAVE Technologies)

Appendix 4-1B

Project Rationale Sample

Example projects…rationalizing the criteria

Project	Electric Vehicle	Exhaust Flow/Temp. Sampler	A.T.V. Service Trailer
Innovation or Development	i) development of the school's existing chassis ii) prototype new chassis/components	diagnostic emissions testing	multi-purpose vehicle carrier/workstation
Function	as per EVOC or similar entry rules	testing procedure/device for assessing exhaust blockage	improved service procedures
Vehicle, System or Component	i) systems, components ii) vehicle	system	vehicle
Fabrication Requirements	i) modifying hubs, motors, etc. ii) jig method frame manufacturing	procedure development electronic/mechanical component assembly	metal fabrication
"Parts bin" Requirements	i) hubs, motors, steering knuckles, etc. ii) schedule steel stock	electronic components sample specifications compilation	Winch hydraulic ram safety devices
Min. Performance Benchmark	i) meets entry requirements ii) progression from beginning stage prototype	valid test result	Roadworthy safe
High Performance Benchmark	i) successful competition results ii) improved competition standings	proofed set of samples successful diagnosis	manufacturable
Instruction, Documentation, Follow-up	i) project log, developable project results ii) design peak or "legacy" project for successive years program	data bank instructions patent possibilities	patent possibilities sportsmens' show entry

Appendix 4-1D

The Artistic to Engineering Process

Brainstorming Matrix (note to teacher: change headings as appropriate to project)
Answer in point form how each box will be addressed in your design.

CONCEPTS	User Needs Issue (environment, social, safety)	Engineering Issues (structure, joinery, fabrication techniques)	Aesthetic/Marketing Design (style, colour, efficiency)
Needs analysis How to illustrate how you addressed the problem, and why			
Visualization How to demonstrate ideas; is it easy for others to see what you are attempting			
Range of Ideas How to illustrate the ideas you looked at to arrive at possible solutions			
Modeling How best to model and test the ideas			
Materials What materials are appropriate, how are they joined, what considerations are needed			
Tools, Resources What is available; what tools and techniques are available			
Time Constraints How to illustrate the time it would take to develop the concept, to fabricate the solution			

Appendix 4-1C

Define the Challenge: Developing a Design Brief

(Use this to come up with ideas for creating your Design Brief)

Define the Big Challenge:

Criteria (what needs to be considered)

Brainstorming and Research (list sources)

Safety (list safety issues pertaining to the challenge)

List technical skills (needed in developing the solution)

The Team (who and what each will do for the team effort)

When (when will things get done and who is responsible)

Appendix 4-1D

Develop A Framework: Brainstorming ideas

During the design process, brainstorming helps to determine if an idea is practical, feasible or attainable, once it has been designed. Many of the hybrid /prototypes vehicles never make it beyond the planning stage. Brainstorming in vehicle design may require constant sketching to reflect the changing modifications and effectively communicate those changes to your peers.

Ideas	Sketches
1-	
2-	
3-	
4-	
5-	

Appendix 4-1E

Develop A Framework: Solutions to Test

Choose some concepts or ideas you have and list the good (PROS) points and the bad (CONS) of your ideas. No idea is too crazy!!

Pros	Cons
1-	
2-	
3-	

Appendix 4-1f

Vehicle System Design Evaluation Rubric

Expectation	Level-1 (50 - 59%)	Level-2 (60 - 69%)	Level-3 (70 - 79%)	Level-4 (80 - 100%)
The student can identify the prototyping procedure to produce a solution to a given problem	- demonstrates limited knowledge of the prototyping procedure to produce a solution to a given problem	- demonstrates some knowledge of the prototyping procedure to produce a solution to a given problem	- demonstrates considerable knowledge of the prototyping procedure to produce a solution to a given problem	- demonstrates thorough knowledge of the prototyping procedure to produce a solution to a given problem
The student demonstrates competence in examining range of ideas	- demonstrates limited competence in examining range of ideas	- demonstrates some competence in examining range of ideas	- demonstrates considerable competence in examining range of ideas	- demonstrates exceptional competence in examining range of ideas
The student can properly identify major issues outlined in design challenge (i.e., ergonomics, aerodynamics, etc.)	- demonstrates limited knowledge of design issues	- demonstrates some knowledge of design issues	- demonstrates considerable knowledge of design issues	- demonstrates exceptional knowledge of design issues
The student has tested and rationalized engineering aspects of design	- demonstrates limited effort in testing, limited knowledge of rationalization	- demonstrates adequate effort in testing, adequate knowledge of rationalization	-demonstrates comprehensive effort in testing, comprehensive knowledge of rationalization	- demonstrates exceptional comprehensive effort in testing, exceptional knowledge of rationalization
Scientific and engineering concepts have been researched and incorporated	- demonstrates limited knowledge of scientific and engineering concepts	- demonstrates some knowledge of scientific and engineering concepts	- demonstrates considerable knowledge of scientific and engineering concepts	- demonstrates exceptional knowledge of scientific and engineering concepts
Demonstrates knowledge of environmental issues in rationalizing design decisions	- demonstrates limited knowledge of environmental issues in rationalizing design decisions	- demonstrates some knowledge of environmental issues in rationalizing design decisions	- demonstrates considerable knowledge of environmental issues in rationalizing design decisions	- demonstrates exceptional knowledge of environmental issues in rationalizing design decisions

The student has completed the prototype safely and with respect to others	- seldom works safely, or respects others and facility	- sometimes demonstrates safe working habits and respect for others	- usually demonstrates safe working habits and respect for others	- always demonstrates safe working procedures, demonstrates leadership in working with others
The student can produce accurate scaled drawings	- demonstrates limited understanding and competence in scaling drawings	- demonstrates some understanding and competence in scaling drawings	- demonstrates considerable understanding and competence in scaling drawings	- demonstrates exceptional understanding and competence in scaling drawings

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Appendix 4-1G

Sample Student Log Sheet

Student: Course:

Date	Hours	Project	Activity Performed	Teach Sig.
Total Hours		Student Signature/date: Instructor Signature/date:		

Activity 4.2: Implementing Vehicle Design Ideas

Time: 120 minutes

Description

Students implement designs developed in the previous activity. Students fabricate completed design solutions, test for operative elements, and present solutions to the class. Students analyze and test material properties in their solutions, and describe scientific and engineering principles used in their designs. Students achieve excellence, originality, and integrity in one's own work and support these qualities in the work of others through Christian leadership.

Strand(s) & Learning Expectations

Strand(s): Theory and Foundation, Skills and Processes Impact and Consequences

Theory and Foundation

Overall Expectations

TFV.01 - apply the design process to develop solutions, products, processes, or services in response to challenges or problems in transportation technology

TFV.02 - describe how materials and processes are used to produce solutions to meet human needs and wants related to transportation

TFV.04 - describe the forms of energy used to power vehicles and transportation systems and explain the different types of energy conversion used for each.

Specific Expectations

TF1.01 - explain how human needs or wants related to transportation can be met through a new or improved vehicle or system

TF1.02 - apply the following steps of the design process to solve a variety of transportation technology challenges or problems:

- identify what has to be accomplished (the problem);
- gather and record information, and establish a plan of procedures;
- brainstorm a list of as many solutions as possible;
- identify the resources required for each suggested solution, and compare each solution to the design criteria, refining and modifying it as required;
- evaluate the solutions (e.g., by testing, modelling, and documenting results) and choose the best one;
- produce presentation and working drawings, sketches, graphics, mathematical and physical models, or a prototype of the best solution;
- evaluate the prototype and determine the resources, including computer applications, required to produce it;
- communicate the solution, using one or more of the following: final drawings, graphs, charts, sketches, technical reports, electronic presentations, flow charts, mock-ups, models, prototypes, and so on;
- obtain feedback on the final solution and repeat the design process if necessary to refine or improve the solution.

Skills and Processes

Overall Expectations

SPV.03 - use a variety of communication techniques to model and communicate product ideas, materials, and specifications;

SPV.04 - use mathematical and language skills and apply technological and scientific principles in the design, construction, and modification of vehicles and infrastructure for various modes of transportation.

Specific Expectations
SP1.04 - use fabrication techniques to mock up or model potential solutions to a transportation technology challenge;
SP1.05 - test materials and products to develop the best solution to a transportation technology challenge;
SP2.01 - select and use a wide variety of hand and machine tool procedures to repair, service, fabricate, and modify a vehicle or a transportation system;
SP2.02 - measure electrical flow, weight, capacity, length, area, volume, and pressure when diagnosing problems in vehicles and transportation systems;
SP3.01 - interpret assembly drawings to identify and describe the components of a vehicle or a transportation system;
SP3.05 - prepare and present effective oral reports about a product or process;
SP4.02 - apply appropriate scientific principles or practices when selecting and specifying materials, determining forms of energy conversion and power transfer, and designing ergonomically effective vehicles.

Impact and Consequences

Overall Expectations
ICV.02 - describe, and apply where appropriate, the exemplary practices that are essential to safe work environments and practices.

Specific Expectations
IC2.01 - apply safe work practices when performing transportation-related processes.

Ontario Catholic School Graduate Expectations
CGE3f - examines, evaluates, and applies knowledge of interdependent systems (physical, political, ethical, socio-economic, and ecological) for the development of a just and compassionate society;
CGE5f - exercises Christian leadership in the achievement of individual and group goals;
CGE5g - achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others.

Prior Knowledge & Skills

Teachers should review basic safety procedures throughout the activity. A basic understanding of modelling and fabrication techniques, reading scaled drawings, and measurement techniques developed in previous activities.

Planning Notes

Students fabricate their solutions to the vehicle design project initiated in Activity 1. Teachers should ensure all materials and tools are ready before initiating this activity. Teachers should also ensure all safety equipment, signage, guards, safety eyewear, etc., are readily in place, and that all students have been properly trained on the specific equipment required to complete their projects.

Teachers are to ensure students are maintaining their journal/logs (see Appendix 4-1G). These logs are to be incorporated in their Design Report, and used to assess individual student effort in group activities.

Teachers may elect to invite community guests to the final presentation/competition.

Teaching/Learning Strategies

Stage 1: Fabrication of Designs
Students are given the task of implementing their design ideas from Activity 4.1. Teachers approve models/mock ups/prototypes from Activity 4.1 before students begin to implement their designs. The teacher ensures that students are aware of proper procedures and safety precautions prior to equipment use.

Teachers approve design changes during student progress, and make students aware of any potential problems of their design. Students must explain to the teacher the need for any modifications to the original design. Students must document any changes in their daily logs or project journals.
Teachers initiate discussion with students to develop concrete action plans to ensure completion of this activity. Students develop a plan of action (see Appendix 4-2A). Students are reminded of the qualities of leadership, and how as Christians we have a responsibility to strive toward excellence in all our work, and to assist others in that goal. Catholic goals are to be included in the Action Plan.
Students complete their work using safe and clean practices. Designs are fabricated from drawings and models produced in Activity 4.1. Any further modifications to designs are to be reflected back to original drawings, and incorporated in to the engineering report .

Stage 2: Engineering Report
Students develop an engineering report (see Appendix 4-2B, and 4-2C) outlining engineering aspects of their designs, including:

- a report of materials used in their solutions. (describing material properties);
- a description of the energy system used for motive power;
- a description of the control system used (steering, stopping, speed control);
- a description of the process they used to develop the solution, including a log of their hours spent on each aspect of the task;
- a description of how their design can improve transportation of goods or people.

Stage 3: Presentation
Students present their project to the class and invited guests. They explain the process that was followed to complete the project. Students present their findings and conclusions on the viability of the vehicle design addressing the engineering issues outlined in Activity 4.1. (This presentation may take place before or after any competition if applicable.)

Assessment & Evaluation of Student Achievement

Students are assessed daily on safe and clean working habits, following rules and guidelines, and demonstration of measurement and scaling skills. Students are evaluated on proper use of materials and material fabrication processes, and the quality of finished products. Students are evaluated individually (see Appendix 4.2D, Sample Vehicle Design Assessment Chart). The Engineering Report and Design Journal are used for evaluation, along with verbal conferencing and presentations.

Accommodations

Program accommodations may include ensuring availability of accessible equipment and tools, extra help in organization of time, or with specific fabrication tasks such as welding. Other accommodations may include extra teacher-student conferencing, teacher-student-parent conferencing, small group learning, peer tutoring, and the use of a buddy system.

Opportunities for enrichment may include enhanced detailed research reports on engineering or scientific principles as related to the project, in-depth testing of materials or physical aspects of the vehicles, or requiring detailed computer generated drawings or animations.

Resources

(refer to sites listed in 4-1a)

Print Resources

Jensen, Cecil H. *Interpreting Engineering Drawings*. Delmar Publishers, 1980.
ISBN 0-17-601756-9

Jellison, R. *Welding Fundamentals,* 1st ed. Prentice Hall, 1996. ISBN 0-13-107178-5

Other
Manuals on specific fabrication tools
Ontario Health and Safety Act
WHMIS MDS sheets as applicable

Appendix 4-2A

Action Plan

Research the necessary skills required (materials, carving techniques, etc.).
Demonstrate the safe use of a variety of tools /technology in completing prototypes assembly.
Delegate the work equally between all group members.

WHO DOES WHAT	WHAT WE NEED TO KNOW Safe operating techniques Safety considerations
WHAT TECHNOLOGY DO WE NEED	**WHAT SKILLS DO WE NEED**

Appendix 4-2B

Engineering Report Format Template

1. **Title Page**
   The title page is used to grab the attention of the reader. As such, it should contain some form of illustration that appeals to the reader. It should also contain the name of the report, the name(s) of the person(s) that produced the report, for whom the report has been prepared, and the date of production.
2. **Problem Statement**
   The problem statement describes the identified needs and situation of the project at hand. This statement is very brief (approximately one or two sentences).
3. **Design Criteria**
   This section outlines the set of factors that will influence the design, such as cost considerations, size limitations, user requirements, material or component properties, etc. This is the section that guides the design. It may be in bullet form, but as much detail as known should be here.
4. **Procedure Notes**
   This should be an in-depth account of the process used in the design and fabrication of the product. The sentences in each paragraph should be kept short and to the point. It should describe the route used to determine the solution to the design challenge, including research conducted, sources of information, modeling and testing of ideas and their results.
5. **Materials**
   List all the materials and analysis of their properties (including costs if applicable), used in the fabrication of the final product.
6. **Drawings or Illustrations**
   Include all drawings or illustrations that were used in the development and fabrication of the project. This includes rough sketches, technical drawings, and illustrations and/or photographs of models or products. Ensure all drawings are properly labelled and descriptive.
7. **Conclusion**
   Describe the results of the process of finding a solution to the design challenge. Include the results of testing solutions. Include a description on how each of the design criteria was met (or not). Describe possible improvements or modifications for future work. Suggest other users or situations that may benefit from your research and/or testing.
8. **References**
   This is a list of all reference materials that students used in order to complete the project, including books, articles, interviews, and Internet sources.
9. **Log Sheet**
   From your daily log records, list the dates and amount of hours taken for each facet of the project. Each team member should include his or her personal time log.

Appendix 4-2C

Sample Vehicle Design Report Rubric

Criteria	Level 1 (50 – 59%)	Level 2 (60 – 69%)	Level 3 (70 – 79%)	Level 4 (80 – 100%)
Knowledge/ Understanding Project Requirements TFV.02, TFV.04; TF1.01	- demonstrates limited knowledge of project requirements and material selection	- demonstrates some knowledge of project requirements and material selection	- demonstrates considerable knowledge of project requirements and material selection	- demonstrates thorough knowledge of project requirements and material selection
Thinking/Inquiry Design TFV.01; TF1.02; SP1.05; SP2.01; SP3.01	- applies few of the skills involved in a design process	- applies some of the skills involved in a design process	- applies most of the skills involved in a design process	- applies all or almost all of the skills involved in a design process
Communication Drawing Conventions SPV.03, SPV.04; SP1.04; SP2.02; SP3.05	- uses language, symbols, and visuals with limited accuracy and effectiveness	- uses language, symbols, and visuals with some accuracy and effectiveness	- uses language, symbols, and visuals with considerable accuracy and effectiveness	- uses language, symbols, and visuals with a high degree of accuracy and effectiveness
Application Model Building ICV.02; IC2.01	- uses procedures, equipments, and technology safely and correctly only with supervision	- uses procedures, equipments, and technology safely and correctly with some supervision	- uses procedures, equipments, and technology safely and correctly	- demonstrates and promotes the safe and correct use of procedures, equipments, and technology

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Appendix 4-2D

Sample Vehicle Design Assessment Chart

At the end of this activity, students and teachers evaluate the appropriate sections of this assessment chart.

Student:

Student self evaluation:
Please refer to the rubrics supplied (Appendix 4-2C) to evaluate your performance and check off what you consider is the correct level for your own work, and return this to the teacher for evaluation.

Expectation	Level 1	Level 2	Level 3	Level 4
Design Brief				
Sketches				
Scaled Drawings				
Models/prototypes				
Safe and clean procedures				
Presentation of solution				
Engineering concepts				
Prototype construction techniques				
Prototype quality				
Finished product quality				
Design report				
Final Presentation				

Appendix 4-2D (Continued)

Teacher evaluation by:

Please refer to the rubrics supplied (Appendix 4-2C) to assess this student's performance and check off the correct level.

Expectation	Level 1	Level 2	Level 3	Level 4
Design Brief				
Sketches				
Scaled Drawings				
Models/prototypes				
Safe and clean procedures				
Presentation of solution				
Engineering concepts				
Prototype construction techniques				
Prototype quality				
Finished product quality				
Design report				
Final Presentation				
Final Unit Evaluation and Comments				