Public and Catholic District School Board Writing Partnerships

Course Profile

Technological Design

Grade 11
University/College
TDJ3M

• *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.

Spring 2001

Acknowledgments

Public and Catholic District School Board Writing Teams –

This profile was a collaborative effort between the Simcoe County District School Board and the Institute for Catholic Education (ICE).

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Course Overview
Technological Design, Grade 11, University/College, TDJ3M

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

Course Description

This course provides students with opportunities to apply the principles of technological design to challenges in communications, manufacturing, electronics, transportation, architecture, industrial and consumer products, health and safety equipment, and environmental services. Students identify user needs, estimate labour and material costs, analyse material characteristics, and illustrate design solutions, using traditional and computer-based methods. Students also acquire the basic design skills required for postsecondary studies in engineering, manufacturing, architecture, and construction.

How This Course Supports the Ontario Catholic School Graduate Expectations

The role of Technological Education in the Catholic faith community enables students to develop and utilize their gifts and talents while creating products that benefit others in a way that models Gospel values. The focus of the curriculum enables students to become critical and innovative problem-solvers who question the use of resources and understand the implications of technological innovations. An emphasis on process as well as results ensures that students create products and provide services that recognize our God-given responsibility to respect the dignity and value of the individual and the global community. Collaboration and leadership are emphasized as students work as a team to create a work/learning environment that is safe, welcoming, and respectful of the individual.

Course Notes

This course is designed to lead to Grade 12 Technological Design (TDJ4M), which may then lead to postsecondary studies in engineering, industrial or commercial product design, architecture, or graphic design. Students learn to develop ideas from problem identification through testing and to prepare for presentation of final solutions. The key components of this course are the development of creative problem-solving skills, application of scientific testing methods, technical drawing and modelling, fabrication skills in a variety of materials, and presentation of ideas to clients and end users.

Many of the skills developed in this course can be applied to a variety of careers. A list of careers involved in design are outlined in Human Resources Development Canada's (HRDC) National Occupational Classifications (NOC) database, partially listed next, (see Resources for HRDC NOC website).

NOC Code	Occupation Category
2131	Civil Engineer
2132	Mechanical Engineer
2133	Electrical and Electronic Engineer
2134	Chemical Engineer
2142	Metallurgical and Materials Engineer
2143	Mining Engineer
2144	Geological Engineer
2145	Petroleum Engineer
2146	Aerospace Engineer

2147	Computer Engineer
2151	Architect
2152	Landscape Architect
2162	Computer System Analyst
2225	Landscape and Horticulture Technician and Specialist
2231	Civil Engineering Technologist and Technician
2232	Mechanical Engineering Technologist and Technician
2241	Electrical and Electronic Engineering Technologist and Technician
2251	Architectural Technologist and Technician
2252	Industrial Designer
2253	Drafting Technologist and Technician
5241	Graphical Designers and Illustration Artists
5242	Interior Designers
5243	Theatre, Fashion, Exhibit and Other Creative Designers

Teachers should be cognizant of the career exploration component of this course. It is suggested that teachers make use of community-based projects and call on local engineers, architects, and design professionals to contribute to student understanding of career paths in the design industry.

In this course, students are given a variety of progressive challenges to encourage creative, fully rationalized solutions. Activities can be teacher- or student-driven and are undertaken on an individual or group basis.

It should be noted that the "design process" (identify the problem, identify related criteria, develop possible solutions, test ideas, produce a solution, and evaluate), is really a development process or cycle. Design is the "front end" to the development process and permeates the entire cycle of developing products and environments. To illustrate this, designers do not ask how they can develop a better mousetrap; they ask why a mousetrap is needed in the first place.

Designers examine a situation and ask the following questions:

- Who has a need, a change in need, a problem, or a situation that could be improved through design?
- What has changed to lead to this need or problem?
- Why does this need or problem exist?
- When and where does this need or problem occur?
- How can the situation be improved?

The prime directive in design is problem solving. Design begins with identifying a situation or problem that relates to a need or a change in need. An important aspect is the continual process of testing, rationalizing, and analysing to ensure the best solution to a given problem is developed.

This course is divided into four units, each unit representing progressively more student responsibility and effort.

In the first unit, students are introduced to techniques and strategies used to generate design ideas. Short, quick prototyping projects are designed to develop creative problem-solving skills. The unit ends with problems relating to students' lives, to make them aware of the techniques for identifying needs and analysing solutions.

In the second unit, students concentrate on the technical aspects of communicating ideas through technical drawings and sketching (both manual and computer-generated), 3-D modelling and simulations, and model fabrication. Students learn the processes of communicating to fabricators and builders through industry-standard techniques and tools.

In the third unit, students investigate the societal impacts of design and learn to appreciate how appropriate design and engineering should lead to improving people's lives and protecting the environment.

In the fourth unit, designed as a sequence of activities leading to a culminating performance task, students apply their skills and knowledge to solve problem situations through design principles learned in the previous units.

Throughout this course, it is important that students explore problem solving from many aspects, and that craftsmanship in all deliverables is paramount to success.

Appropriate fabrication techniques and the safe use of required tools and equipment must remain an important focus throughout each activity. The teacher models appropriate, safe working habits through demonstrations and continual practice. Before initiating any work in a shop environment, the teacher ensures that students demonstrate safe operating procedures. The use of a Safety Passport, (Appendix A), is strongly suggested.

Units: Titles and Time

Unit 1	Generating Designs	20 hours
Unit 2	Technical Design	30 hours
* Unit 3	Design and Society	30 hours
* Unit 4	Applications of Design	30 hours

* These units are fully developed in this Course Profile.

Unit Descriptions

Unit 1: Generating Designs

Unit Description

Students engage in a series of activities that establish techniques for creative problem solving in a variety of design situations. Activities focus on the various methods used to generate and communicate ideas through sketching and illustration techniques; research and investigation skills; and decision-making skills. Through these methods, students begin to create, adapt, and evaluate new ideas in light of the common good and think reflectively and creatively to evaluate situations and solve problems. Emphasis is on engineering design, prototyping (or "sketch modelling") as a design process, and the development cycle of products. The societal impact of their solutions is examined, and students are encouraged to integrate Gospel values and responsible attitudes in their ideas and solutions.

Unit Overview Chart

Activity	Time	Expectations	Assessment	Tasks
1: Engineering Physics and Materials: The Plastic Airplane Competition	5 hours	TFV.05, TF1.02, TF2.01, TF3.02 SPV.02, SP1.01, SP1.04, SP2.03, ICV.04, IC2.03 CGE2b, 3e, 4f, 5b, 7b	Knowledge Inquiry Application	- Design, build, and fly the largest airplane, made entirely of recycled or found paper/plastics, in a distance competition
2: Rapid Prototyping: Designing Tools	5 hours	TFV.01, TFV.03, TFV.05, TF1.01, TF1.02, TF1.03, TF2.01, TF2.03, TF3.02 SPV.02, SPV.05, SP1.04, SP2.03 ICV.01, ICV.03, ICV.04, IC1.01, IC1.02, IC2.02, IC2.03 CGE2e, 3b, 3c, 4f	Knowledge Inquiry Communication Application	- Design and fabricate a model or prototype of a tool for a chosen occupation or sport (e.g., foam model for ergonomic testing)
3: Designing for Human Needs	10 hours	TFV.01, TFV.04, TFV.05, TF1.01, TF1.02, TF1.03, TF2.01, TF2.03, TF3.01, TF3.02 SPV.02, SPV.03, SPV.04, SPV.05, SP1.01, SP1.02, SP1.04, SP1.05, SP2.03 ICV.01, ICV.03, ICV.04, IC1.01, IC1.02, IC2.03 CGE1d, 2e, 3d, 4a, 4f, 5d, 7d, 7j	Knowledge Inquiry Communication Application	- Design, build, and test a device that would make a task in the home or school safer and/or easier

Unit 2: Technical Design

Unit Description

The focus of this unit is on the technical aspects of communicating design ideas. Engineering and design concepts are explored through problem-solving activities. Technical drawing, 3-D modelling, testing, and report developments are key areas explored in this unit. Research of historical design enables students to understand the evolution of today's products and buildings. Students use and integrate the Catholic faith tradition, in the critical analysis of the arts, media, technology, and information systems, to enhance the quality of life. Students assess products for aesthetics, function, and safety while applying human values and socially responsible criteria.

Unit Overview Chart

Activity	Time	Expectations	Assessment	Tasks
1: The View: Sketching and Drawing	10 hours	TFV.02, TF2.02, TF2.03 SPV.01, SP2.01 ICV.04, ICV.05 CGE4f, 5g	Knowledge Communication Application	- Create a portfolio of simple 2-D/3-D drawings of the device from Unit 1, Activity 2 or Activity 3
2: Developing Working Drawings	10 hours	TFV.02, TFV.03, TF1.03, TF2.02, TF2.03, TF3.01 SPV.01, SPV.02, SPV.03, SP1.02, SP1.03, SP1.05, SP2.01 ICV.01, ICV.03, IC1.01, IC1.02, IC2.02 CGE4f, 5g	Knowledge Communication Application	- Generate working drawings, assembly drawings, and analysis report of selected devices from the home or school
3: 3-D Modelling Architectural Design Renovation	10 hours	TFV.01, TFV.02, TFV.05, TF1.01, TF1.04, TF2.01, TF2.02, TF2.03, TF3.01, TF3.02 SPV.01, SPV.02, SPV.03, SPV.04, SPV.05, SP1.02, SP1.05, SP2.01, SP2.03 ICV.04, ICV.05, IC2.03, IC3.01, IC3.02 CGE4f, 2c, 3b, 4d, 7a, 7d, 7i, 7j	Knowledge Inquiry Communication Application	- Generate a 3-D model (virtual and/or physical) of a proposed addition to an existing historical structure - Identify careers in architecture and construction

Unit 3: Design and Society

Unit Description

Advances in technology have had a profound impact on individuals and societies throughout history. This unit examines the effect of design on societies in the past, present, and future, while allowing students to engage in problem-solving activities based primarily on humanitarian and environmental issues. In developing and applying technology to the issues, students have the opportunity to use their knowledge to formulate attitudes and values based on social responsibility and the Gospel, to develop one's God-given potential, and to make a meaningful contribution to society. Students have the opportunity to apply their knowledge and begin to formulate attitudes and values towards the development and application of technological design based on social responsibility and the Gospel.

Unit Overview Chart

Activity	Time	Expectations	Assessment	Tasks
3.1: An Introduction to Renewable Energy	3 hours	TFV.05, ICV.02 CGE 4f, 5g	Knowledge Communication	Research and present information on energy use
3.2: Solar Water Purification System	9 hours	TFV.01, .05, SPV.01, .05, ICV.01 TF1.01, 2.01, .02, 3.02, SP1.01, 2.01, IC2.03 CGE 4f, 5g	Knowledge Communication Application	Design and construct a water purification system
3: Design and Construct a Solar-powered Device using Photovoltaic (PV) Cells	13 hours	TFV.05, SPV.01, .04, .05, ICV.01, .04 TF1.02, 2.02, .03, SP1.01, .02, .04, .05, 2.03, IC2.03 CGE 2c, 3b, 4d, 4f	Knowledge Thinking/Inquiry Communication Application	Design and construct a device powered by PV cells

Unit 4: Applications of Design

Unit Description

In this culminating unit, students draw upon all the knowledge, skills, and values they have learned to help them develop appropriate solutions to design problems. Students explore the development of design challenges from the situation identification stage through to solution analysis.

This unit provides students with a broad overview of the design and development cycle of typical products. Activity 1 focuses on a project that would be found in an architectural design firm, while Activity 2, the course culminating activity, continues with a final product that could be accomplished through an architectural, graphics, or industrial design firm. The goal is to provide postsecondary bound students with tasks that highlight the nature of careers in the design industry.

Unit Overview Chart

Activity	Time	Expectations	Assessment	Tasks
1: Design of Public Cultural Spaces	15 hours	TFV.01, TFV.02, TFV.03, TFV.05, TF1.01, TF1.02, TF1.04, TF2.01, TF2.02, TF2.03, TF3.01, TF3.02 SPV.01, SPV.02, SPV.05, SP1.01, SP1.04, SP2.01, SP2.03 ICV.01, ICV.04, IC2.01, IC2.03 CGE4f, 4c, 5a, 5e, 5f	Knowledge Inquiry Communication Application	Design and build a model of a cultural centre or exhibition display
2: Design of an Information Kiosk/Device	15 hours	TFV.01, TFV.02, TFV.05, TF1.01, TF1.02, TF1.03, TF2.01, TF2.03, TF3.01, TF3.02 SPV.02, SPV.03, SPV.05, SP1.01, SP1.02, SP1.04, SP1.05, SP2.03 ICV.01, ICV.03, ICV.04, IC1.01, IC1.02, IC2.02, IC2.03 CGE2b, 2c, 4f, 7g	Knowledge Inquiry Communication Application	Design, test, and fabricate a prototype of a futuristic device or kiosk for disseminating information in public places

Teaching/Learning Strategies

Technological Design involves generating solutions to human needs problems and requires a hands-on, project-based approach that incorporates individual and team efforts, a flexible process for creative idea generation, and a variety of materials and tools to model, test, and communicate solutions. In a typical design project, the teacher provides students with a design brief, which describes the problem to be solved or need to be satisfied, 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.

Before initiating the project, it is important to provide students with the assessment criteria and discuss the strategies for attaining their maximum potential. Teachers should discuss the production and maintenance of portfolios as each activity begins.

Teachers may elect to provide students with a list of projects at the beginning of the course or 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, modelled after a typical design or engineering firm where individuals with differing strengths, skills, and knowledge work together to solve problems or issues.

Individual Effort

- Students work individually to accomplish specific tasks. This may include research, reporting, or tasks related to a group project such as drawing, drafting, model building, or presentation preparation.

Class Discussion

- Students actively participate by taking turns discussing current issues.
- Teachers may direct discussions by posing initial questions, demonstrating specific procedures (e.g., proper, safe tool operation), or presenting a media topic related to the current activity (e.g., a video or newspaper clipping).

Theoretical Study

- Students learn concepts and theory in application through the study and analysis of case studies.
- Students test and observe scientific and engineering principles through experimentation, Socratic lessons provided by the teacher or invited guests, or assignments that involve research and investigation into critical issues as applied to the current activities.

Important issues such as safety should be reinforced throughout the course. Following initial discussions and testing, (see Appendix A - Safety Passport), teachers should reintroduce specific topics at the time required, (e.g., before cutting wood on a table saw, the teacher should review specific table saw safety items). This Just-In-Time (JIT) method ensures students have more than one opportunity to learn very important skills.

In Technological Design, the computer is used extensively to: generate illustrations and drafted drawings; generate and test 3-D models; research on-line resources; communicate with peers and experts in the field; produce products with Computer Numerical Control (CNC); and produce finished prints, reports, and presentations.

If there are insufficient computer resources, teachers should ensure that there are plenty of activities involving conventional illustration and/or sketching, conventional library or text research, hand modelling, and testing. Teachers may generate and post a checklist that encompasses a wide range of tasks so students have opportunities to accomplish goals independent of resource limitations. This checklist could identify the to-do tasks from each ongoing activity (e.g., drawings or models to be completed, finishing tasks, or report writing), as well as facility tasks (e.g., clean-up, lab prep, or equipment repair).

Design ideas and concepts can be generated through a variety of methods, including group brainstorming, conducting surveys or interviews of clients or end users, developing and testing of prototypes or models, or discussions with workers in the relevant field of study.

A key component of this course is for students to be informed of career opportunities in the field of design. Strategies such as inviting guest speakers, conducting field trips or industry visits, participating in community based projects, encouraging and marketing job shadowing, and co-op or apprenticeship placements are recommended. While career-related expectations are addressed in only a few activities, career awareness is implicit in all activities and should be reinforced, by posting newspaper clippings and posters from design schools and conducting periodic discussions about career paths and opportunities.

Assessment & Evaluation of Student Achievement

This course is project-oriented, student-driven, and involves creative solutions to open-ended problems. Assessment and evaluation criteria must be clearly indicated to students during project initiation. Performance can be assessed through analysis of completion of established criteria and by the student's own rationalization of design ideas. Rationalization can be evaluated through verbal testing, written design reports, formal student presentations, and daily logs or journals. Teachers should assess the individual student's progress through daily observation and comment, group or individual conferencing, and/or self or peer-assessment.

Assessment and evaluation tasks may include:

- composition of design briefs (research and analysis);
- composition of design proposals;
- technical and/or design reports;
- research reports (including photos of product in use);
- drawings, illustrations, and/or blueprints;
- finished models, prototypes, test models, and products;
- presentations;
- competition deliverables;
- daily log or work journal.

Teachers ensure all students participate in the activities and are evaluated on individual merits, even while working within a collaborative group. Possible strategies include:

Individual deliverables

- a research report;
- an analysis report;
- presentation;
- fabricated product or model.

A daily job or task sheet

- to be signed by the student and the teacher;
- attached to an end report, which clearly indicates each group member's respective accomplishments.

Individual conferencing

- teacher-to-student discussions to assess development and encourage motivation.

Development of individual portfolios, daily notes, and/or daily journals for assessment.
While this course is designed to create an atmosphere of a design firm, teachers may elect to conduct written tests to reinforce theoretical concepts. Knowledge of important theoretical facts and processes can be assessed through written tests of terminology, procedures, and/or application of learned concepts. It is suggested that the culminating performance task be comprised of a design situation that assesses the student's knowledge of the complete design and development process. A summative exam can be connected to the final culminating performance task if deemed necessary by the teacher.

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.

Accommodations

Teachers using this course profile should provide all students with as many opportunities as possible to develop their God-given potential. Various accommodations may be made throughout the program to assist students with various physical and developmental needs, including one-on-one teaching/conferencing, adaptation of handouts, small-group learning, and/or peer tutoring. Activities should be modelled to meet the needs of all learners by applying various accommodations such as allowing increased time for activities and facilitating peer tutor assistance where possible. Teachers are expected to be acquainted with students' Individual Education Plans (IEPs) and the unique learning characteristics of individual students and to make the necessary accommodations.

Specific accommodations in Technological Design activities include:

- additional assistance in idea development tasks, including step-by-step assistance;
- templates to assist in completing drawings or reports;
- peer tutoring or additional help in drafting, modelling, computer, or fabricating tasks;
- heterogeneous groupings to provide opportunities for peer assistance and tutoring;
- sample completed assignments (i.e. exemplars) with grading scheme if possible;
- directed idea generation tasks, one-on-one assistance in developing ideas;
- modified requirements: additional computer-based assignments, advanced finishing or modelling requirements.

Teachers should be aware of students who require modification to the mandated expectations for this course. *Ontario Secondary Schools* (page 24) allows teachers to modify the learning expectations for exceptional students in order to support the contents of the student's IEP. This also applies to students who have not been identified as exceptional but are receiving Special Education programs and services.

Resources

Pamphlets, calendar information, and websites from universities, colleges, and schools of design provide information on careers in design and engineering. Guidance or Student Services Departments should have written materials and CDs of information. Teacher/librarians should be consulted for information on historical developments in particular fields, current practices and search strategies for publications and Internet based research. Teacher/librarians should be consulted for information on historical developments in particular fields, current practices, and search strategies for publication- and Internet-based research.
Internet sites on design can be found by searching on major keywords such as design, industrial design, engineering (e.g., civil, mechanical, electronic, etc.), and/or graphic design. Keyword searches direct the student and/or teacher to sites useful for background research. Local bookstores and web-based booksellers sell design-related books as well.

Catalogues from local hardware or building supply stores can be consulted for materials and project resources. Students should consult local hobby, hardware, and lumberyard personnel for ideas on solving design problems and insights on material properties and fabrication techniques.
Various resources are used throughout the course, including websites, guest speakers, company literature, videos, trade and industry magazines, and textbooks.

Books

Gordon, J.E. *The New Science of Strong Materials*. Markham, Ontario: Penguin Books, 1978. ISBN 0-306-80151-5

Gordon, J.E. *Structures, or Why Things Don't Fall Down*. Markham, Ontario: Penguin Books, 1978. ISBN 0-306-80151-5

Huchinson, Karsnitz. *Design And Problem Solving*. ISBN 0.8273.52441.1

Jensen, Cecil H. and J.D. Helsel. *Engineering Drawing and Design*. Glencoe McGraw Hill. ISBN: 0028017951

Norman, Donald A. *The Design of Everyday Things*. New York: Doubleday, 1988. ISBN 0-385-26774-6

Papanek, Victor. *Design for the Real World: Human Ecology and Social Change*. Chicago: Academy Publishers, 1999. ISBN 0897331532

Salvadori, Mario. *The Art of Construction, Projects and Principles for Beginning Engineers and Architects*. Chicago: Chicago Review Press, 1990. ISBN 1-55652-080-8

Taylor, John R. and Chris D. Zafiratos. *Modern Physics for Scientists and Engineers*. New York: Prentice Hall, 1991. ISBN 0135897890

Publications

Publications on many aspects of architectural design considerations and research are available from:
ASTM testing standards
Canada Mortgage and Housing Canadian Housing Information Centre, Ottawa Ontario
Canadian Standards Association

Fraser catalogue

Machinery's Handbook

Model making manuals and magazines are available from local hobby stores

Ontario Building Code

Spae-Naur catalogue

Sweet's Catalogue

Periodicals

Popular Science.

Popular Mechanics.

Various architecture and home improvement magazines

Wired.

Video

Videos on the design process and projects such as washing machines, bicycles, toys, and mobile homes are available from
Classroom Video
107 1500 Hartley Avenue, Coquitlam, BC V3K 7A1

Associations

APEO (Association of Professional Engineers of Ontario)

Design associations

OACETT (Ontario Association of Certified Engineering Technicians and Technologists)

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.

Human Resources Development Canada National Occupational Classification database
www.hrdc-drhc.ca/noc

Ontario Prospects, (career explorations)
www.edu.gov.on.ca

Scotty's Unofficial Centre for Tech Education – resources for teaching design
www.millenniumwave.com

Wired Magazine – trends and future directions of technology
www.wired.com

Popular Science – latest innovations in industrial and architectural design
www.popoularscience.com

Popular Mechanics – latest information of innovations and inventions
www.popularmechanics.com

History of Technology – list of resources on the development of technology
www.englib.cornell.edu/ice/lists/historytechnology/historytechnology.html

Carleton University School of Industrial Design – information on industrial design curriculum
www.id.carleton.ca

Core77 Design Network – information on design careers, competitions, events
www.core77.com/

Bad Designs – examples of problems in consumer design
www.baddesigns.com

How Things Work
www.howthingswork.com

Vocabulary definitions
www.whatis.com/index.htm

Tech Streets – standards and information (ASTM, CSA, ISO, etc.)
www.techstreet.com

CSA International
www.csa.ca

Sweet's.com – construction industry resources
www.sweets.com

American Standards for Testing and Materials (ASTM)
www.astm.com

International Directory of Design – universities, associations, journals, events, etc.
www.penrose-press.com/IDD/search.html

Tech Streets – standards and information (ASTM, CSA, ISO, etc.)
www.techstreet.com

OSS Considerations

The Grade 11 Technological Design course is designated as a Technological Education program in which students develop an understanding of the process of developing products and services for user needs. Course policy is outlined in *The Ontario Curriculum, Grades 11 and 12, Technological Education, 2000*. Program and diploma requirements are found in *Ontario Secondary Schools, Grades 9-12, Program and Diploma Requirements, 1999*.

For a broad overview of this course, teachers should also refer to policy in *The Ontario Curriculum, Grades 9 and 10, Technological Education, 1999* and *The Ontario Curriculum, K-8, Science and Technology, 1998*. Curriculum profiles for Grade 9 Integrated Technologies and Grade 10 Technological Design can be found online at www.curriculum.org.

The analysis, research, fabrication knowledge, and skills derived from this course can be applied to any career path a student may wish to pursue. Potential for career exploration throughout all units is available to students with specific reference to *Choices Into Action: Guidance and Career Education Program Policy for Elementary and Secondary Schools, 1999*. Teachers should also consult their local Ontario Apprenticeship branch for information on trade apprenticeships and the Ontario Youth Apprenticeship Program, (OYAP), available from the Ontario Ministry of Training, Colleges, and Universities. Ideas for projects related to career explorations can be found in *Ideas in Action: Summary of Pilot Projects for the Bridges School to Work Transition Program 1999,* Volumes 1 and 2.

Appendix A

Safety Passport

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 them independently.

The general process is as follows:

1. When the teacher introduces a new piece of equipment (e.g., lathe), students record the date of the safety demonstration on their safety passport (see sample). Students prepare notes in their notebooks during this lesson while the teacher demonstrates techniques for the safe operation of the machine and personal protective equipment (e.g., proper eye protection, secure loose hair, remove jewellery, protective clothing, etc.). This safety note is carefully recorded in each student's notebook along with the signed passport slip. If any students are absent for the safety lesson, the teacher carefully notes it on the daily attendance and a make-up opportunity must be provided.
2. 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 set-up and operation of the equipment by a student, the teacher signs off that portion of their passport.
3. 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. These individual machine tests are designed to complement any general facility safety rules. Upon satisfactory completion of the test, the student dates the "tested" column and the teacher initials it as complete.
4. Once the student has completed steps 1, 2, and 3, the teacher signs the final column of the student's safety passport indicating they are able to use that equipment. *The teacher keeps the signed passports on file*. A summary document of all the various permissions may be created by the student and signed by the teacher (as permissions are earned). See the sample summary passport below.

Equipment Safety Passport

School: Instructor:

Student Name: Equipment:

See your instructor for ANY questions about the safe set-up and operation of equipment.

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

Coded Expectations, Technological Design, Grade 11, University/College Preparation, TDJ3M

Theory and Foundation

Overall Expectations

TFV.01 · use the design process to create products or services based on an analysis of consumer needs and market requirements;
TFV.02 · follow Canadian Standards Association (CSA) drawing practices (e.g., using standardized symbols; orthographic projection; and applicable codes such as the Ontario Building Code, the Electrical Safety Code, and municipal by-laws) when creating drawings;
TFV.03 · describe manufacturing and construction processes used in industry;
TFV.04 · describe the significance of the components contained in a technical report;
TFV.05 · determine project criteria and evaluate solutions to decide how well the criteria have been met.

Specific Expectations

Planning
TF1.01 – evaluate consumer needs and expectations in relation to a specific product;
TF1.02 – evaluate the suitability of materials to meet the project criteria based on the materials' properties and costs, and on the manufacturing methods being used;
TF1.03 – describe manufacturing processes used in engineering;
TF1.04 – describe construction processes used in architectural technology.

Preparing Designs
TF2.01 – apply the design process to develop solutions for a particular product or service;
TF2.02 – create technical drawings that reflect appropriate line type, weight, and density;
TF2.03 – use technical illustrations, drafting, computer graphics, and models to present ideas and solutions.

Evaluating and Documenting Designs
TF3.01 – identify, in technical reports, factors (e.g., materials, fabrication methods, trends, costs, ergonomics, alternative solutions) that influence design decisions for a particular product;
TF3.02 – evaluate solutions to ensure that project criteria are met.

Skills and Processes

Overall Expectations

SPV.01 · follow drafting conventions to produce technical drawings;
SPV.02 · analyse the physical characteristics of common building and manufacturing materials proposed for a design solution;
SPV.03 · produce technical reports and design briefs that follow a prescribed format;
SPV.04 · estimate the materials, fabrication, and labour costs associated with a project;
SPV.05 · build effective models and prototypes.

Specific Expectations

Planning

SP1.01 – create effective design briefs that outline consumer needs and any other requirements or limitations that will affect the design solution;

SP1.02 – produce technical reports that follow a prescribed format;

SP1.03 – identify materials for particular projects based on desired physical properties using technical reference material such as *Machinery's Handbook*, *Sweet's Catalogue*, or *Architectural Graphics Standards*;

SP1.04 – determine whether proposed materials are suitable for a specific product;

SP1.05 – write effective technical reports that include sections such as the following: Design Brief, Criteria and Constraints, Idea Development, Planning, Design Analysis, Evaluation, Design Solution, Product Description.

Preparing Designs

SP2.01 – create accurate drawings (e.g., floor plans, perspectives and elevation views, section and assembly drawings) using both traditional (drafting board) and computer-based methods;

SP2.02 – estimate the costs of materials and fabrication methods for particular projects by performing quantity take-offs;

SP2.03 – fabricate models and prototypes following standard safety procedures.

Impact and Consequences

Overall Expectations

ICV.01 · identify concerns related to technical design, such as product safety, durability, costs, choice of materials, and ergonomics;

ICV.02 · identify actions that can be taken in response to environmental concerns;

ICV.03 · describe liability issues that necessitate the inclusion of safety features in a product's design;

ICV.04 · follow safe operating procedures for tools and materials;

ICV.05 · identify a variety of careers in engineering, architecture, or industrial design and the educational requirements for each.

Specific Expectations

Design Impacts

IC1.01 – describe problems caused by improper or inadequate design;

IC1.02 – identify existing products that could be improved and explain problems in these products that resulted from inadequate design.

Environmental and Safety Issues

IC2.01 – explain different methods of handling materials and waste generated by the construction or manufacturing industries;

IC2.02 – describe safety issues, constraints, or legislation that would affect the design of a particular project and explain how these restrictions would affect design documentation and drawings;

IC2.03 – handle materials and tools safely.

Education, Training, and Career Opportunities

IC3.01 – identify a variety of careers in engineering, architecture, or industrial design;

IC3.02 – identify the educational and other requirements for a career in engineering or architecture that is related to technological design.

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 3: Design And Society

Time: 30 hours

Unit Description

Advances in technology have had a profound impact on individuals and societies throughout history. This unit examines the effect of design on societies in the past, present, and future, while allowing students to engage in problem-solving activities based primarily on humanitarian and environmental issues. Students have the opportunity to apply their knowledge and begin to formulate attitudes and values towards the development and application of technological design that are based on social responsibility and the Gospel. The concept of renewable energy and its implications for society are examined, with an emphasis on its practical applications.

Unit Synopsis Chart

Activity	Time	Expectations	Assessment	Tasks
3.1: An Introduction to Renewable Energy	3 hours	TFV.05, ICV.02, CGE 4f, 5g	Knowledge Communication	Research and present information on energy use
3.2: Solar Water Purification System	9 hours	TFV.01, .05, SPV.01, .05, ICV.01, TF1.01, 2.01, .02, 3.02, SP1.01, 2.01, IC2.03, CGE 4f, 5g	Knowledge Communication Application Thinking/Inquiry	Design and construct a water purification system
3.3: Design and Construct a Solar-powered Device using Photovoltaic (PV) Cells	13 hours	TFV.05, SPV.01, .04, .05, ICV.01, .04, TF1.02, 2.02, .03, SP1.01, .02, .04, .05, 2.03, IC2.03, CGE 2c, 3b, 4d, 4f	Knowledge Thinking/ Inquiry Communication Application	Design and construct a device powered by PV cells
3.4: Career Exploration in Design	5 hours	TFV.03, ICV.05, TF1.03, .04, IC3.01, .02, CGE 2c, 4f, 7a,d,i,j	Thinking/ Inquiry Communication	Research and present information on Careers in the Design Industry

Activity 1: An Introduction to Renewable Energy

Time: 180 minutes

Description

This introductory activity develops students' knowledge and attitudes towards energy choices that they make everyday. Through an analysis of their personal use of energy, students are encouraged to develop an attitude of conservation as a means to protecting the earth's resources. By relating this activity to renewable energy, students exhibit an understanding of the potential uses of renewable resources on a personal level. They also develop attitudes regarding the history and social implications of the use of renewable energy on a global scale. Using God-given gifts to create environmentally friendly and socially responsible projects is explored.

Strand(s) & Learning Expectations

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

Overall Expectations

TFV.05 - determine project criteria and evaluate solutions to decide how well the criteria have been met;
ICV.02 - identify actions that can be taken in response to environmental concerns.

Specific Expectations

TF1.01 - evaluate consumer needs and expectations in relation to a specific product.

Prior Knowledge & Skills

- Students should be familiar with the various forms of energy usage and the term "conservation."
- Students should be familiar with concepts of various forms of energy, such as electrical, fossil fuels, non-renewable, and renewable.
- Students should be able to research using the Internet and other resources.
- Students should be able to work in cooperative groups.

Planning Notes

- The teacher gathers resources about renewable resources. Contact industry representatives in the area in order to determine what informational materials can be collected from different sources.
- Arrange for group visits or a guest speaker to the class to discuss the issues of conservation and the history of renewable energy.
- Arrange a visit to an outdoor education/conservation centre to highlight the need for renewable energy as well as to provide an opportunity to see various forms of renewable energy at work.
- Form heterogeneous groupings of students for the jigsaw activity and allow for a 15-minute explanatory session to familiarize them with the jigsaw process.
- Cross-curricular connections are possible with History. Classes could partner with the Geography teacher to determine areas of Canada most suited to renewable resource use. The teacher could also partner with the Physics teacher when providing lesson on energy sources.

Teaching/Learning Strategies

- A teacher-directed discussion is initiated to determine the ways in which we use energy in our society. The discussion could touch on various points including how electrical energy is produced now and what alternatives exist. Focus students on thinking about renewable energy and what resources are available now. Many current textbooks offer an introduction to renewable energy choices. (See Resources.)
- Teachers could employ a cooperative learning exercise such as the jigsaw method in which students group together and become experts in a given topic and then return to a home group to teach the other students the material. (Refer to Appendix 3.1.)
- From these research and teaching sessions, students should be prepared to identify and discuss the history and benefits of renewable energy, the uses of renewable energy in developing countries, and organizations to be used as resources in developing ideas and projects about renewable energy. Students describe their own energy usage and develop plans for improving conservation with respect to their energy usage.
- Presentation of the research information is achieved through small-group sharing in the home groups. Teachers may choose to test students' knowledge in the form of a written quiz or take-home written report.

Assessment & Evaluation of Student Achievement

Students are assessed on their research and cooperative learning skills. Knowledge of the topics discussed is assessed through a written exercise that focuses on one or more areas of concern in the jigsaw activity. (Examples can be found in Appendix 3.1 – Jigsaw Information Activity, Follow-up Questions section.) Teachers should look for a broad range of the subjects covered during the “Expert” period of the activity while paying particular attention to environmental and consumer themes.

Accommodations

- Provide individual and small-group explanatory sessions.
- Allow for students of differing abilities to be paired up in the audit process.
- Provide information sheets to assist in the research process.
- Consult the student’s IEP to determine areas of need.
- Have students give their information orally to the group, with little or no written work.

Enrichment

- Choose an appliance in your home and determine the amount of energy used by that appliance over the course of a day.
- Develop a plan to decrease the personal demand on the energy resources in the home. Follow the plan and chart its success or failure.

Resources

Augustin, J. *The Solar Car Book*. Berkeley, CA: Ten Speed Press, 1982. ISBN: 0898150183

Energuide for houses: Government of Canada website assisting in determining energy usage and conservation – http://oee.nrcan.gc.ca/houses-maisons/english/choose_e.htm

Kortright Centre for Conservation – http://www.kortright.org/

Schools Going Solar Website – http://www.schoolsgoingsolar.org/

Solar Energy: Towards the Sun. National Film Board of Canada, 1978.

Solstice: Centre for Renewable Energy and Sustainable Technology (CREST) – http://solstice.crest.org/index.shtml

Sunwind: An excellent Canadian website that offers details about the history of solar energy as well as educational supplies and many links – http://www.web.net/~sunwind/

Appendix 3.1

Jigsaw Information Activity (Teacher Information Sheet)

1. Divide students into five* heterogeneous groups. Number the groups 1-5. These are your "Home" groups.

2. Give each member of the home groups a letter from A-E. These are the new group identifiers that form your "Expert" groups.

3. Have the Expert groups form together and hand out one research assignment to each group. Examples of research topics are:
   - The history of renewable energy/solar power use;
   - The use of renewable energy in the developing world;
   - Opportunities for conservation;
   - Examples of Canadian uses of renewable energy (pay special attention to local projects.);
   - Organizations that are involved in socially responsible renewable energy projects.

4. The expert groups should have access to newspapers, magazines, Internet, and the Library/Resource Centre in order to develop the research.

5. After the expert groups have had an opportunity to research their topics, students return to their home groups.

6. Give each expert an opportunity to discuss their list of items researched with their home group members.

7. Each home group should be given an opportunity to demonstrate the information they learned in the form of a quiz, a written report, or an advertisement.

Follow-up Questions
Possible choices that could be given to students to determine learning throughout the jigsaw process are:

a) Describe examples where Canada is promoting the development of renewable resources.

b) What are some significant events in the history of solar energy use?

c) Conservation or solar power: which makes more economic sense?

d) How are Catholic agencies using renewable energy sources in developing countries?

e) Describe ways in which we could use solar energy or renewable resources in our everyday lives. Where are the greatest costs in these examples?

* (Numbers vary based on number of students participating.)

Activity 3.2: Solar Water Purification System

Time: 540 minutes

Description

One of the major hardships faced by people in the third world or developing nations is the shortage of fresh drinking water. The same can be said of people in a refugee situation. As members of a Christian society, we look to develop ways to serve the needs of our fellow people while conserving the ideals of appreciation of the world given to us by a loving God. This activity enables students to design and construct a simple water purification system using solar power.

Strand(s) & Learning Expectations

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

Overall Expectations

TFV.01 - use the design process to create products or services based on an analysis of consumer needs and market requirements;
TFV.05 - determine project criteria and evaluate solutions to decide how well the criteria have been met;
SPV.01 - follow drafting conventions to produce technical drawings;
SPV.05 - build effective models and prototypes;
ICV.01 - identify concerns related to technical design, such as product safety, durability, costs, choice of materials, and ergonomics.

Specific Expectations

TF1.01 - evaluate consumer needs and expectations in relation to a specific product;
TF2.01 - apply the design process to develop solutions for a particular product or service;
TF2.02 - create technical drawings that reflect appropriate line type, weight, and density;
TF3.02 - evaluate solutions to ensure that project criteria are met;
SP1.01 - create effective design briefs that outline consumer needs and any other requirements or limitations that will affect the design solution;
SP1.05 - write effective technical reports that include sections such as the following: Design Brief, Criteria and Constraints, Idea Development, Planning, Design Analysis, Evaluation, Design Solution, Product Description;
SP2.01 - create accurate drawings (e.g., floor plans, perspectives and elevation views, section and assembly drawings) using both traditional (drafting board) and computer-based methods;
IC2.03 - handle materials and tools safely.

Prior Knowledge & Skills

- Internet research skills.
- Students who have taken the Grade 10 Technological Design course may be familiar with the unit dealing with the construction of emergency shelters for refugees in war-torn countries or natural disasters.
- Principles of renewable energy discussed in Activity 1.
- Students may be familiar with a CAD drawing program.
- Students should have familiarity with the design process of working from a situation to construction of a model, and an ability to apply it to a given situation.
- The concepts of creating and administering a fair test of a product based on criteria set out by students at the beginning of a project.
- Students have knowledge of the water cycle.

Planning Notes

- Teachers may want to make various newspaper articles or videos, dealing with issues of third-world countries or people in refugee situations, available in their classrooms. To highlight the need for pure drinking water in refugee situations, a guest speaker could be arranged, in coalition with the Religious Education Department, from Catholic Development and Peace, Catholic Relief Services, or the Red Cross. Arrange access to a computer lab for use of CAD Program if necessary.
- Teachers could pursue cross-curricular connections with Science with the process of analysing the purity of water and with the Geography department in exploring physical and social concerns of water purification.
- Collect a variety of found materials (e.g., cardboard boxes, scrap wood, plastic pieces.) Teachers should also explore the possibility of an excursion to a water purification plant.
- *An important safety note:* Water samples should not be ingested, as the purity of the water cannot be completely assured. In order to test water for purity, arrange to have the samples tested by a test facility in your area.
- Discuss standards of effective Internet research and set the parameters of acceptable usage before any computer research session begins.

Teaching/Learning Strategies

- The teacher centres discussion on the issue of the problems facing people of the third world (refer to the Grade 10 Technological Design profile, Unit 5, with respect to the emergency shelter activity). Shelter would be a major concern as would be the availability of fresh water for drinking. A discussion and research into the processes of water purification in Ontario, also dealing with the issues surrounding contaminated water in our own province could be beneficial to students' understanding of these complex issues.
- The teacher hands out Appendix 3.3 and considers with students some of the scenarios where a water purifier might be a necessity. Students should be encouraged to look at the situation of developing countries and the work of relief agencies there. Students should direct their research to the process of concentrating the heat energy of the sun. Also of note to research are countries and areas where a device such as this would be helpful. Compile a list of reflective and insulating materials that would maximize the solar power to the pasteurizer. Encourage students to look for supplies of these materials. Brainstorm materials that would be available to begin the process. Look at the processes involved in designing and building a water purification system using readily available and found materials.
- In groups of three to five, students find examples of pastuerizers and distillers on the Internet or in science textbooks. Using the design situation in Appendix 3.3, have students begin the design process. Each student completes a final report, including:
  - sketches of ideas;
  - development of ideas;
  - research threads ;
  - bibliography;
  - scale drawings (by hand or CAD);
  - materials list;
  - final evaluation of the prototype or model.
- Groups complete a working model of the pasteurizer/distiller and test it as part of the final evaluation. (A self-reflection form can be found in Appendix 3.4.) Part of the testing process is a test of the purity of the water. Students arrange to have their water tested for purity (by a science class or by an outside test facility).
- *Do not allow students to drink any water in order to test its purity.*

Assessment & Evaluation of Student Achievement

Ongoing assessment of the progress of the design process should be discussed with students through personal conferencing opportunities on a regular basis. Students evaluate their own progress, in collaboration with the teacher, by referring to Design and Practical Evaluation Scheme, included in Appendix 3.2. The design assessment focuses on the conventions of drawing and drafting, research, and documentation of the progression of the process, as well as the presentation of the final design brief. The practical application of the design is assessed throughout the design and construction process, as well as with the final prototype. The focus of the evaluation is on safe building practices, functionality, and ongoing evaluation of the product. Throughout the process, students monitor their own progress based on the evaluation scheme provided.

Accommodations

- Provide individual and small-group explanatory sessions if needed.
- Provide a basic plan for the model.
- Allow additional time if necessary.
- Consult individual IEPs to determine particular areas of need.
- Choose materials to be used to assist physically challenged students.
- Pair students with little or no knowledge in computer operations with students who have expertise.
- Have students construct a solar oven as an alternative.

Enrichment

1. Develop a system that purifies water on a large scale (e.g., for a community) using solar power. The design should include estimates of how much water can be purified in a specified period of time.
2. Develop the purification system so that it is portable for camping and hiking.

Resources

National Renewable Energy Laboratory. *Science Projects in Renewable Energy and Energy Efficiency*. Utah: American Solar Energy Society, 1991.

Websites

Catholic Relief Services – http://www.catholicrelief.org

Renewable Energy for Remote Communities: Canada – http://cedrl.mets.nrcan.gc.ca/e/412_e.html

Solar solutions – http://www.solarsolns.com/index.html

Appendices

Appendix 3.2 – Design and Practical Evaluation Scheme
Appendix 3.3 – Design and Construct a Solar Water Purifier
Appendix 3.4 – Solar Water Purifier: Self-reflection

Appendix 3.2

Design and Practical Evaluation Scheme

Design Process

Research	A wide range of resources including books, magazines, websites, films. Annotated bibliography. (2 marks for each entry:)	/10	
Sketches	Idea generation sketches with some labels and description. (2 marks each)	/10	
Working drawings	Using CAD program or by hand, including dimensions. Accurate and to scale.	/10	
Daily Log	Detailed daily entries with diagrams and next steps included. Ongoing product evaluation reflected in the entries. (2 marks for each detailed entry.)	/10	
Presentation	Creative brief directed at the intended user of the product. Includes sections that describe the needs of the intended user as well as cost analyses.	/10	
Total Design			**/50 marks**

Practical Process

Safety	Safe and competent use of machines exhibited in each session.	/5	
Time spent on task	Effective use of time exemplified throughout the sessions.	/5	
Aesthetics/ graphics/ materials	Time and care taken to improve the physical appearance of the finished product. Effective use of varied available materials.	/10	
Functionality	The mechanisms are functional all the time. Use of complex mechanisms.	/20	
Evaluation/ Troubleshooting	Ongoing, consistent evaluation and improvements throughout the production process.	/10	
Total Practical			**/50 marks**

Appendix 3.3

Design and Construct a Solar Water Purifier

Design Context: In developing countries, clean drinking water is not readily available. Without facilities to chlorinate drinking water for decontamination, it is necessary to heat the water to a certain temperature for a prolonged period of time. Boiling water is time consuming and expensive in developing countries, so other methods need to be found to improve the drinking supply. Some options exist: Solar Pasteurization or Solar Distillation.

Pasteurization: If water is heated to 149° F (65° C) for about six minutes many of the germs, viruses, and parasites that cause disease in humans are killed, including cholera and hepatitis A and B. It is similar to what is done with milk and other beverages. It is not necessary to boil the water, as many people believe. Pasteurization is not the only way to decontaminate drinking water, but pasteurization is particularly easy to scale down so the initial cost is low.

Distillation: This process extracts pure water from contaminated sources, using the concept of the water cycle and the process of evaporation and condensation using only the sun. It allows students to make fresh water from almost any source - even seawater.

Your task is to design and construct a fully functional: solar water pasteurizer that will heat the water inside to a temperature of 65° C for 30 minutes; or a solar water distiller that causes the water to evaporate in a closed system, traps the condensation, delivers it to a reservoir for collection, and allows for free use of the water when collected.

Investigation

1. What materials would be effective to absorb the heat? To insulate against loss of heat?
2. Explore some other areas where the solar heating of water would be useful. Is it cost effective?
3. How will the solar power be concentrated to maximize the energy source?
4. In developing countries, the concern is to make it inexpensive. What materials fit this criterion?
5. What is the best time of day to pasteurize/distil your water?
6. How is the purity of water tested? Don't drink it! Find a local organization that will test your water.

Construction

In design groups of two, design a device that will heat water and sustain that heat for a period of 30 minutes. Include in your report a scale drawing of your solar water pasteurizer along with any sketches or drawings that influenced your thinking.

Some practical items to consider: a solid cardboard box is a good structure to begin with; reflective and insulating materials can be strategically placed on the box to maximize their effects; the solar absorber should be dark to maximize its effects; the water being pasteurized can be stored in a pot or some other vessel that has good insulating qualities; the distilling reservoir should be easily accessible and the box should be reusable; darkened plastic may be used to act as the solar reflector and water catcher.

Methods of collecting water should be simple and ensure that the device can be reused.

Appendix 3.3 (Continued)

Evaluation
Test your prototype using a standard test agreed upon by the class.
Did your pasteurizer raise the temperature of the water to 65° C? How long did it remain at or above that temperature?
How much water could you pasteurize in a day?
Did your distiller work? How much water was extracted in a given amount of time?
How much water could you distil in a day?
How can we check for purity?

Extensions
Modify your solar water pasteurizer to double as a solar cooker.
Attempt to distil salt water. What are the results?

Appendix 3.4

Solar Water Purifier: Self-reflection

Name:
Date:

1. Test your solar water pasteurizer/distiller using the method agreed upon by the class. Did your device pasteurize the water according to the standard of achieving 65° C for a period of at least 30 minutes? Did the distilling work?

2. Was your water purified? How did you determine this?

3. Looking at the device, what are three design aspects that contributed most to its success? Give a brief explanation describing your reasons for the choices.

4. What are three design aspects that you would change if you had to make this again? Give a brief explanation describing your reasons for the choices.

5. While working in a group we often find ourselves contributing in different ways. Be detailed about two of the ways that you contributed to the project.

6. Describe how your project could be used by a relief agency in a developing country or in a refugee situation.

Activity 3: Design and Construct a Solar-powered Device using Photovoltaic (PV) Cells

Time: 780 minutes

Description

The initiative to make use of renewable energy sources is growing as the cost and availability of non-renewable resources makes them less desirable. In remote areas, in particular under-developed countries, renewable resources such as solar power are practical alternatives to traditional resources. PV cells are used to supply power to cottages and homes in North America, as well as to communities in developing countries. The International Space Station is employing photovoltaic cells to supply unlimited power to the system. Students design and build a device that is powered by PV cells. The device should fulfill a needed service. Special attention is paid to the belief that we have a duty as members of the Catholic Church to protect the Earth and to use its resources wisely.

Strand(s) & Learning Expectations

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

Overall Expectations

TFV.05 - determine project criteria and evaluate solutions to decide how well the criteria have been met;
SPV.01 - follow drafting conventions to produce technical drawings;
SPV.02 - analyse the physical characteristics of common building and manufacturing materials proposed for a design solution;
SPV.04 - estimate the materials, fabrication, and labour costs associated with a project;
SPV.05 - build effective models and prototypes;
ICV.01 - identify concerns related to technical design, such as product safety, durability, costs, choice of materials, and ergonomics;
ICV.04 - follow safe operating procedures for tools and materials.

Specific Expectations

TF1.02 - evaluate the suitability of materials to meet the project criteria based on the materials' properties and costs, and on the manufacturing methods being used;
TF2.02 - create technical drawings that reflect appropriate line type, weight, and density;
TF2.03 - use technical illustrations, drafting, computer graphics, and models to present ideas and solutions;
SP1.01 - create effective design briefs that outline consumer needs and any other requirements or limitations that will affect the design solution;
SP1.02 - produce technical reports that follow a prescribed format;
SP1.04 - determine whether proposed materials are suitable for a specific product;
SP1.05 - write effective technical reports that include sections such as the following: Design Brief, Criteria and Constraints, Idea Development, Planning, Design Analysis, Evaluation, Design Solution, Product Description;
SP2.03 - fabricate models and prototypes following standard safety procedures;
IC2.03 - handle materials and tools safely.

Planning Notes

- A lesson on electrical safety is an effective way to begin this activity. Teachers need to assess their goals, i.e., size of the project and photovoltaic cells to be used, before commencing. Teachers may also want to look into partnerships with corporations dealing with solar power or purchase small panels for reuse in their program. Create heterogeneous groups of three to five students as design and construction teams.
- Various sizes of PV cells can be purchased from surplus electronics stores and on-line. Rechargeable batteries can also be purchased if storage of power is going to be part of the designs. PV cells are extremely delicate therefore it is necessary to incorporate methods to ensure their care (e.g., gluing the panels to a corkboard or a permanent fixture). Arrange to have various materials for construction:
  - electrical wire, tools, voltmeters, testers, and connections;
  - golf cart battery or equivalent;
  - wood, metals, or plastic for prototypes;
  - motors or electrical device for power to be supplied.
- Plan to visit a home or conservation area that uses PV solar power for a portion of its energy. Arrange a guest speaker on the topic. Photocopy Appendices 3.5 and 3.6 for each student.
- Refer to Activity 3.2 in Technological Design: Workplace for ideas related to the patent process.
- Cross-curricular connections can be found with the Communications Technology Department by developing an infomercial to extol the virtues of the product created. As well, teachers could work in conjunction with the Physics Department when teaching the electricity component. Connections with the Religious Education Department when dealing with environmental impacts of energy and the benefits of using renewable resources could be explored.

Teaching/Learning Strategies

A: Research and Materials Discovery (3 hours)

- The teacher should allow time and resources for research on the uses of photovoltaic cells in society. Appendix 3.5 can be given to students as a reference. Students explore reasons why solar power would be used in various geographical areas (e.g., remote areas where it is not possible to connect to a power system; developing countries where electrical power is not readily available). Discussion includes details regarding inclusion in the power company's grid and methods of reducing dependency on non-renewable sources.
- Brainstorm various types of devices that use PV cells for energy. Some examples that students may be familiar with include streetlights, billboards, and highway signs. Continue the session with possibilities of new ideas for consideration. If possible, teachers provide a demonstration of the power output of various sizes of PV cells. Electrical safety should be included in this lesson and throughout the project. Hand out the Glossary (Appendix 3.5) and ask students to become familiar with the terminology and explore new terms to add to the list.
- Students test and measure the output of the solar cells with the goal of maximizing the output and determining limitations. A discussion of the pros and cons of series and parallel circuits is valuable. For example to increase the voltage output of a system, for shorter-term applications, series circuits are useful (e.g., four 6-volt batteries connected in series offer a 24-volt output over a shorter period of time). Further research could include the discussion of inverters and how the shape of the wave is changed in the inversion from Direct Current to Alternating Current.

B: Prototype Design and Construction (9 hours)
Using Appendix 3.6 as a guide, students begin the process of designing a device powered by photovoltaic cells. Design and construction vary depending on available resources.

1. If larger PV cells are available (5 to 50W of power), the design challenge can be expanded to include full-scale models and prototypes. The focus is on the design of a new solar electric powered device or an improvement on an existing device. The PV cell can supply power directly to the motor or device, or it can charge a battery.
2. The activity can be geared to developing a power supply for existing appliances in the classroom or school. Groups may provide power to a lighting system, machine, or device in the classroom.
3. A simple circuit can be developed to light a DC light bulb directly from the solar cell. Use of a simple regulator may be required.
4. Using small, hobby-type solar cells, students design and construct a vehicle or device that performs a particular function. Students could design and construct a scale model of the project using small 1.5V motors. This could be part of a design competition that contains possibilities for further construction of a full-scale model for the design groups with the greatest competence.
5. Students develop a system to power a radio or communication device, which could be used in remote areas or refugee situations where power is not easily accessible.

C: Presentation (1 hour)

- The final presentation is in the form of a reporting procedure that mirrors a professional presentation. The presentation includes sketches from the development of ideas, as well as detailed drawings using traditional drafting forms or a CAD program. Cost analysis and comparisons with other forms of energy should be an integral part of the reporting process.
- There are many practical applications for using solar energy in the home and in society. The presentation of projects should reflect the possible benefits to the environment. Students include the benefits of the application for a certain user, either personal or business. This could be in the form of an oral presentation with a working model and cost analysis that would encourage a user to invest in the product. In collaboration with the Communications Technology Department, students can develop an infomercial on the subject, thereby using less of class time for formal presentations.

Assessment & Evaluation of Student Achievement

- Students are assessed on an ongoing basis for their problem-solving abilities and interactions within the group, based on teacher observations and conferencing with students. The ability to test and evaluate their designs is assessed through direct teacher observation and entries in the student's personal daily log. A copy of the assessment rubric (Appendix 3.7) is made available to students during the activity. Included with Appendix 3.6 is a marks breakdown, which should be given to and discussed with students before the activity begins. Daily conferencing with students should reflect familiarity with the content of the breakdown or Appendix 3.7.
- The prototype is evaluated on its effectiveness, as well as its correlation to the parameters of the design context.
- In the oral presentation, students are assessed on their ability to effectively articulate environmental benefits of the model, cost analysis of the materials, and the projected use of the technology in the prescribed setting.

Accommodations

- Provide small-group and individual explanatory sessions where necessary.
- Allow additional time.
- Allow for small-scale electronics projects using hobby PV cells.
- Enrichment: Students improve designs to participate in a competition if possible.
- Begin the process to submit ideas for patent.
- Use suggestions in students' IEPs.

Resources

Print

Browning, Heighington, Parvu, and Patillo. *Design and Technology*. Toronto: McGraw-Hill Ryerson, 1993. ISBN 0.07.549650.X

Maycock, P.D. *A Guide to the Photovoltaic Revolution; Sunlight to Electricity in One Step*. Emmaus, PA: Rodale Press, 1985.

Natural Resources Canada. *Photovoltaic Systems: A Buyer's Guide*. Minister of Supply and Services Canada, 1989. ISBN 0-662-16385-0

Wright, T. *Technology Systems*. Illinois: The Goodheart-Willcox Co. Inc., 1996. ISBN 1-56637-263-1

Websites

Canadian Intellectual Property Office (Obtaining patent information) – http://cipo.gc.ca

Photovoltaic Experiments in Space – http://www.geocities.com/CapeCanaveral/Lab/2690/apexmain.htm

Solar Energy Light Fund – http://www.self.org

How Stuff Works – www.howstuffworks.com

Solar Power Competition Websites:

Queen's University Solar Car – http://www.solarcar.queensu.ca/main.php

Solar Design Contest – www.crest.org/renewables/prseat/contest00/index.htm

Solar Bike and Car Race – www.azsolarcenter.com/education/comp1.htm

Appendices

Appendix 3.5 – Solar Power Glossary of Terms
Appendix 3.6 – Design and Construct a Solar-powered Device using Photovoltaic Cells
Appendix 3.7 – Assessment Rubric

Appendix 3.5

Solar Power Glossary of Terms

Alternating Current (AC): Electric current in which the direction of flow is reversed at frequent intervals, usually 120 times per second (60 cycles per second). Opposite of direct current.

Direct Current (DC): Electric current in which electrons flow in one direction only. Opposite of alternating current.

Electrical Grid: An integrated system of electrical distributions, usually over a large area.

Inverter: A device that converts direct current (DC) to alternating current (AC).

Kilowatt-hour (kWh): An amount of energy supplied by one thousand watts for one hour. (1000 watts represent a flow of 1000 Joules of energy provided or used *per second*, and the amount of energy this flow provides or uses for one-hour amounts to one kWh of energy.)

Parallel Connection: A method of interconnecting two or more electricity-producing, or power-using, devices, such that the voltage produced or required is not increased, but the current is additive. Opposite of series connection.

Photovoltaic (PV) Cell: A device that converts light into electricity.

Remote: Not connected to a utility grid.

Series Connection: A method of interconnecting devices that generate or use electricity so that the voltage, but not the current, is additive. Opposite of parallel connection.

Wattage: A measure of electric power. Power is an amount of work (work is measured as a change of energy and can be measured in Joules (J) or kWh) done in a unit of time. One amp of current flowing at a potential of one volt produces one watt of power.
Watts = Volts x Amps

Appendix 3.6

Design and Construct a Solar-powered Device using Photovoltaic Cells

Design Context
Alternative forms of energy are becoming more accessible due to the lowering of costs and environmental awareness. Solar power is a renewable resource that is being used in many different contexts. For example, remote areas are using PV cells to power homes, lighting, and water pumping systems. Space exploration teams are using PV cells to provide power to the International Space Centre and satellites deployed on various missions. Consider how PV cells can be used to power an original system or one that has significant improvements. The power can be supplied directly to the system or it can be stored in a battery system of your design.

Research
- Find five different uses of photovoltaic cells in use today.
- Describe the method of storage for power that will be used later.
- Brainstorm at least five possibilities for PV cell usage in your school and community or for use in a developing country or remote area. (Provide sketches of two of the possibilities.) The possibilities could include new ideas in addition to ideas that offer improvements on existing products.
- Some possibilities for consideration: solar-powered remote-control airplane; solar-powered cooling fan; emergency desalinization unit; solar-powered portable radio; solar wearable clothing; or a solar-powered hammock swing. Power a robotic arm: automation and industry sorting device—recycling sorters. Power a small DC motor or light fixture.
- Decide on one project as a group. Be creative. Begin with a scale drawing of the project including electrical wiring and storage of power possibilities. Provide a materials list and approximate costs for your device. (Be specific.)
- Connect with someone in industry who can offer some guidance or assistance with the project. There are many organizations that offer guidance through the Internet.

Construction
In design groups, design and construct a device that uses PV cells to provide power to complete a task. The device can be useful for the school, a home, or a remote area not serviced by regular electrical service. It must obtain all of its power from solar energy. It may use a battery to store the energy for use in non-peak sunlight hours.

Presentation
Your final report is a presentation to a business or individual who would benefit from your design. It should include the purchase price in addition to the potential costs when compared with traditional forms of energy; potential benefits to the community and the environment; and the feasibility of the product in everyday use. The report could be an oral presentation with a working model and cost analysis that would encourage a user to invest in the product. You could also choose to create an infomercial in collaboration with the Communications Technology Department.

Appendix 3.6 (Continued)

Evaluation
Test your prototype using a fair test, developed by your group, based on the task your device performs. Test it under full-sun and no-sun scenarios in order to test the battery storage system.

Extensions
- Develop your idea to be included in a national or school competition.
- Consider beginning the patent process to protect your design for future development.

Evaluation

Presentation

Graphics (incl. sketches; scale drawings; cost analysis graphs)	10 marks	
Research (further reading on the subject: Internet sites, magazines, government initiatives)	10 marks	
Product Knowledge (articulation of the technology employed; explanation of product; ability to field questions effectively)	20 marks	
Daily Log	10 marks	
Total:		*50 marks*

Project

safe and competent use of equipment	10 marks	
time spent on task; consistent contributions to the group effort	10 marks	
use of mechanics/complexity; the project works safely	20 marks	
durability; choice of materials; consideration of ergonomics	10 marks	
Total		*50 marks*

Appendix 3.7

Sample Assessment Rubric: Design and Construction of Solar-powered Device

Categories	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Knowledge/ Understanding Understands the technology associated with photovoltaic cells. SPV.02	- demonstrates limited knowledge of technology associated with photovoltaic cells	- demonstrates some knowledge of technology associated with photovoltaic cells	- demonstrates considerable knowledge of technology associated with photovoltaic cells	- demonstrates thorough knowledge of technology associated with photovoltaic cells
Knowledge/ Understanding Understands the uses of solar energy SPV.02	- demonstrates limited knowledge of the uses of solar energy	- demonstrates some knowledge of the uses of solar energy	- demonstrates considerable knowledge of the uses of solar energy	- demonstrates thorough knowledge of the uses of solar energy
Thinking/Inquiry Use of materials and solutions to design and construct a prototype. TFV.05; SPV.02; SPV.05; TF1.02; SP1.04; SP2.03	- applies few of the skills involved in the inquiry/design process	- applies some of the skills involved in the inquiry/design process	- applies most of the skills involved in the inquiry/design process	- applies all or almost all of the skills involved in the inquiry/design process
Communication Use of industry standard symbols on technical drawings TF2.02; TF2.03	- uses language, symbols, and visual with limited accuracy and effectiveness	- uses language, symbols, and visual with some accuracy and effectiveness	- uses language, symbols, and visual with considerable accuracy and effectiveness	- uses language, symbols, and visual with a high degree of accuracy and effectiveness
Application Safety in work practices. ICV.01; ICV.04 IC2.03	- uses procedures, equipment, and technology safely and correctly only with supervision	- uses procedures, equipment, and technology safely and correctly with some supervision	- uses procedures, equipment, and technology safely and correctly	- demonstrates and promotes the safe and correct use of procedures, equipment and technology

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

Activity 4: Career Exploration in Design

Time: 300 minutes

Description

This activity examines the entire development of a product from idea through design, testing, marketing, and finally to the sale of the product in relation to the people involved. The different types of occupations and careers involved in the entire process are explored, along with the education and training needed. Students research career options in design and related fields, gathering information that is later presented to the class.

Strand(s) & Learning Expectations

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

Overall Expectations

TFV.03 - describe manufacturing and construction processes used in industry;
ICV.05 - identify a variety of careers in engineering, architecture, or industrial design and the educational requirements for each.

Specific Expectations

TF1.03 - describe manufacturing processes used in engineering;
TF1.04 - describe construction processes used in architectural technology;
IC3.01 - identify a variety of careers in engineering, architecture, or industrial design;
IC3.02 - identify the educational and other requirements for a career in engineering or architecture that is related to technological design.

Prior Knowledge & Skills

Students should have:

- an understanding of the design process as learned in Units 1 and 2;
- career and educational goals as examined in the student's Annual Educational Plan (AEP) over the past three years;
- an ability to effectively present information to the class using oral and visual methods.

Planning Notes

- In preparing for this activity, teachers need to look at available resources for information and make sure they are readily accessible to students. Teachers may also wish to develop this activity in consultation with the Guidance Department, as there are links to students' Annual Education Plans. There are also integration possibilities with the Teacher Advisor Program. Teachers need to make sure that students have access to materials for presentations, such as overhead transparencies, bristol board, and audio-visual equipment. Reserve needed equipment in advance.
- Planning a guest speaker from industry or arranging a field trip to a local design firm or manufacturing facility would assist in increasing student understanding of the careers involved.

Teaching/Learning Strategies

- The activity begins with a class discussion on the types of occupations and careers that exist in design-related fields of industry. Listed in Resources is a video that can be viewed as a starting point to this discussion and students' research. Begin by reviewing the process that a product will go through, from idea to sales, and have the class identify people who contribute to this process.
- Students then research all the occupations/careers that are involved in the development of a product. Teachers may want to specify a product to focus students' efforts. Simple devices such as a pen, shoe, or coffee table can be used. A general theme or category may also be used (e.g., tools, kitchen devices, or farm equipment), and students can pick a specific product. Either way, teachers should look at the local economy when deciding so students can tap into readily available resources. Research can be done individually or with a partner.
- While gathering information on the types of resources available, students should also look at the minimum qualifications and educational requirements for the occupation and where to obtain any necessary education or training. University and college calendars should be available in the class to simplify this part of the activity. The teacher may want to provide a questionnaire for students to fill out (Appendix 3.8). Students conduct most of the research and complete the questionnaire outside of class time.
- Information is then presented to the class. Students prepare and deliver a five-minute oral presentation that may be accompanied with visuals such as a video, *PowerPoint* presentation, or a kiosk-type display.

Assessment & Evaluation of Student Achievement

Students are assessed on their research and presentation skills, along with their knowledge of career options in design-related fields, qualifications required, and job descriptions. Students complete a questionnaire (see Appendix 3.8) based on the information they gathered researching the topic. The teacher evaluates this questionnaire on how thorough and accurate the information is. Self- and peer assessments are completed on the presentation and an opportunity should be provided for feedback. It is important that the criteria be fully explained at the beginning of the activity, before the presentations begin, so students know what is expected of them and how to accurately assess their peers. Teacher assessment is in the form of a rubric (see Appendix 3.9).

Accommodations

- Arrange heterogeneous groupings. Provide opportunities for peer assistance and tutoring.
- Provide assistance with the occupation search from teacher or peer.
- Allow additional time if needed.
- Extensions and enrichments could include job shadowing or cooperative placement programs.
- Base accommodations on student IEPs where appropriate.

Resources

School Guidance Department and Teacher Advisors
Guest Speakers from Industry and/or Professional Associations

Print

Browning, Heighington, Parvu, and Patillo. *Design and Technology*. Toronto: McGraw-Hill Ryerson, 1993. ISBN 0.07.549650.X

Human Resources Development Canada. *Career Directions*. Ottawa: Canada Communication Group Publishing, 1997. ISBN 0-662-26267-0

National Occupation Classification Career Handbook. Ottawa: Canada Communication Group Publishing, 1996. ISBN 0-660-16300-4

Video
Jobs With A Future: Careers In The Automotive Industry. Automotive Parts Manufacturers' Association

Websites
Career Explorer – www.careerexplorer.com
Canada's School Net – www.schoolnet.ca
Career Paths Online – www.careerpathsonline.com/

CD ROMs
School Finder University. EDge Interactive Publishing, 1999.
School Finder College. EDge Interactive Publishing, 1999.
School Finder Career College. EDge Interactive Publishing, 1999.
Career Cruising 2000 Edition, 1995-98. New Media, Inc., 1998. EasyBase.

Appendix 3.8

Career Exploration Questionnaire

Name:
Date:
Class:

1. What product did you research?
2. List all the occupations that were involved in the development of the product from idea to sales.
3. Which of these occupations are related to the fields of design or engineering?
4. Choose one example mentioned above and describe the responsibilities of the occupation.
5. What are the educational requirements for this position? Describe the various methods to become educated for this occupation.
6. What is an average starting salary for a person with zero years' experience in this occupation? Five years' experience?
7. What types of advancements are available for someone in this type of occupation?
8. What other employers would hire someone in this type of occupation?

Appendix 3.9

Evaluation & Assessment for Activity 4 – Career Exploration Presentation and Questionnaire

Criteria	Peer	Teacher	
Knowledge of Topic	/5	/5	
Preparation and Organization	/5	/5	
Oral Communication Skills	/5	/5	
Visual Communication Skills	/5	/5	
Format of Presentation	/5	/5	
Total			**/50**
		Questionnaire (complete and accurate)	**/50**
		Final Mark	**/100**

Comments:

Unit 4: Applications of Design

Time: 30 hours

Unit Description

In this culminating unit, students draw upon all the knowledge, skills, and values they have learned in the course to develop appropriate solutions to design problems. Students explore the development of design challenges from the situation identification stage through to solution analysis.

This unit provides students with the broad overview of the design and development cycle of typical products. Activity 1 focuses on a project that would be found in an architectural design firm, while Activity 2, the course culminating activity, continues with a final product that could be accomplished through an architectural, graphics or industrial design firm. The goal of this unit is to provide post-secondary bound students with tasks that highlight the nature of careers in the design industry.

Unit Synopsis Chart

Activity	Time	Expectations	Assessment	Tasks
1: Design of Public Cultural Spaces	15 hours	TFV.01, TFV.02, TFV.03, TFV.05, TF1.01, TF1.02, TF1.04, TF2.01, TF2.02, TF2.03, TF3.01, TF3.02 SPV.01, SPV.02, SPV.05, SP1.01, SP1.04, SP2.01, SP2.03 ICV.01, ICV.04, IC2.01, IC2.03 CGE4f, 4c, 5a, 5e, 5f	Knowledge Inquiry Communication Application	Design and build a model of a cultural centre or exhibition display
2: Design of an Information Kiosk/Device	15 hours	TFV.01, TFV.02, TFV.05, TF1.01, TF1.02, TF1.03, TF2.01, TF2.03, TF3.01, TF3.02 SPV.02, SPV.03, SPV.05, SP1.01, SP1.02, SP1.04, SP1.05, SP2.03 ICV.01, ICV.03, ICV.04, IC1.01, IC1.02, IC2.02, IC2.03 CGE4f, 7g, 2b, 2c, 7g	Knowledge Inquiry Communication Application	Design, test, and fabricate a prototype of a futuristic device or kiosk for disseminating information in public places

Activity 1: Design of Public Cultural Spaces

Time: 900 minutes

Description

The focus of this activity is to design a World's Fair pavilion through the research and interpretation of the history, tradition, culture, and commerce of a selected country. Students develop solutions by using a design criteria analysis process, then communicate their ideas through technical drawings, presentation media and models. Students construct structure and floor plan models, as part of a presentation display to highlight design features based on their research.

Strand(s) and Learning Expectations

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

Overall Expectations

TFV.01 - use the design process to create products or services based on an analysis of consumer needs and market requirements;
TFV.02 - follow Canadian Standards Association (CSA) drawing practices (e.g., using standardized symbols; orthographic projection; and applicable codes such as the Ontario Building Code, the Electrical Safety Code, and municipal by-laws) when creating drawings;
TFV.03 - describe manufacturing and construction processes used in industry;
TFV.05 - determine project criteria and evaluate solutions to decide how well the criteria have been met;
SPV.01 - follow drafting conventions to produce technical drawings;
SPV.02 - analyse the physical characteristics of common building and manufacturing materials proposed for a design solution;
SPV.05 - build effective models and prototypes;
ICV.01 - identify concerns related to technical design, such as product safety, durability, costs, choice of materials, and ergonomics;
ICV.04 - follow safe operating procedures for tools and materials.

Specific Expectations

TF1.01 - evaluate consumer needs and expectations in relation to a specific product;
TF1.02 - evaluate the suitability of materials to meet the project criteria based on the materials' properties and costs, and on the manufacturing methods being used;
TF1.04 - describe construction processes used in architectural technology;
TF2.01 - apply the design process to develop solutions for a particular product or service;
TF2.02 - create technical drawings that reflect appropriate line type, weight, and density;
TF2.03 - use technical illustrations, drafting, computer graphics, and models to present ideas and solutions;
TF3.01 - identify, in technical reports, factors (e.g., materials, fabrication methods, trends, costs, ergonomics, alternative solutions) that influence design decisions for a particular product;
TF3.02 - evaluate solutions to ensure that project criteria are met;
SP1.01 - create effective design briefs that outline consumer needs and any other requirements or limitations that will affect the design solution;
SP1.04 - determine whether proposed materials are suitable for a specific product;
SP2.01 - create accurate drawings (e.g., floor plans, perspectives and elevation views, section and assembly drawings) using both traditional (drafting board) and computer-based methods;
SP2.03 - fabricate models and prototypes following standard safety procedures;
IC2.01 - explain different methods of handling materials and waste generated by the construction or manufacturing industries;
IC2.03 - handle materials and tools safely.

Prior Knowledge & Skills

Students should have basic knowledge of design briefs, problem-solving models, basic sketching techniques and terms (e.g., isometric, pictorial), basic CAD techniques, drawing standards, research and referencing techniques, all acquired through previous activities.

Planning Notes

- The teacher prepares an introduction on the nature and history of World Fairs and/or cultural exhibitions. Historical documentation on exhibitions and World Fairs should be located before activity initiation. This information is available in print and Internet form (see Resources). The focus of the activity is to design a national pavilion by analysing the culture of a selected country and interpreting this culture through architectural design. Consequently, a selected theme, such as economic promotion or promotion of national cultural values should be selected in advance. Teachers may wish to pre-select countries, (or provinces in a Canada-wide fair), or allow students to propose their own.
- Students focus on drawing and modelling skills to illustrate research ideas. Drawings and models are arranged in a presentation display that effectively and clearly details the student's research.
- Limiting the model size and establishing a standard scale facilitates economic use of modelling materials as well as planning for scaled drawings. A suggested scale of 1cm:1m with a maximum base size of 60 cm x 60 cm (approx. 2' x 2') is appropriate as it is small enough for class work but large enough for detail.
- Teachers provide materials and equipment for model building, including:
  - masonite, other sheet stock;
  - plastic sheets, rod stock;
  - wood strips, dowel;
  - cardboard;
  - hot melt glue, epoxy, carpenter's glue;
  - styrofoam;
  - modelling clay;
  - modelling trees, printed finishes, etc. (optional);
  - human figures to scale (optional);
  - paints or finishes.
- Teachers may network with teachers of Geography, History, or Social Studies for resources and possible curriculum links.

Teaching/Learning Strategies

- Teachers initiate discussion on the activity parameters, with an overview of historical World Fairs and exhibitions. Teachers present the challenge as a design brief outlining the Situation, Challenge, Criteria, and Constraints. (See Resources and Appendix 4-1A - Design Brief: World's Fair Pavilion.)
- Teachers provide reference material to outline basic structural construction and codes in commercial building. They discuss pedestrian flow, public safety concerns, mechanical and construction needs, environmental considerations, and material properties.
- Teachers review architectural drawing standards and model parameters (e.g., scale, size restrictions).
- Teachers should reinforce concepts of traffic flow and use of space in the structure (e.g., multimedia viewing, stages for presentations, eating areas, rest areas).
- Teachers initiate discussions on construction techniques used in public structures with a focus on waste produced by the construction industry, and discuss possible ways to minimize waste.

- Teachers establish a timetable. A suggested timetable is as follows:

Week 1 (3 hours)	Form groups, write proposals, research references, propose themes to be incorporated in designs with initial sketches (thumbnails, roughs)
Week 1-2 (6 hours)	Development of presentation and working drawings
Week 2 (6 hours)	Model building and completion of presentation displays.

- Students are instructed to examine the construction process as well, in order to describe the process used in their particular solution.
- Students choose design teams and allocate tasks. Design teams propose solutions, identifying criteria to be examined and suggested solutions. Teachers approve proposals before they advance to next step.
- Student teams prepare design illustrations and sketches of test models. Students then develop working drawings to detail scale model.
- Student teams prepare scale models according to working drawings. Students prepare presentation materials, including posters, explanatory notes, photographs, and computer models, as required to highlight and describe the features of their design solutions and to detail the process that would be used to construct their particular solutions. Students consider the issue of waste generated by the construction industry and detail how to minimize waste in their designs. Teams present their work to the class for discussion and evaluation. The presentation include reports on: construction methods employed to construct the pavilion; concepts of relative costs and efficiency of construction (i.e., consideration of waste and environmental issues); and use cycle (i.e., what is done with pavilion after the exhibition).

Assessment & Evaluation of Student Achievement

Assessment and evaluation is focused on the depth of research, quality of communications, evidence of effort, attention to detail, and evidence of justification for design decisions as shown in drawings, design briefs, and verbal presentations. Students are evaluated against the criteria listed in Appendix 4-1A. Evaluation is based on the depth of research, adherence to drawing standards, and quality of presentation of ideas. Model construction should reflect attention to detail, depth of research, valid and justified use of materials (model materials and materials designed for end product), and accurate scale. Presentation drawings, working drawings and sketches should be evaluated for attention to detail, evidence of research, and attention to standards.

- The checklist found in Appendix 4-1B and the assessment rubric in Appendix 4-1C – Sample World’s Fair Pavilion Rubric are used as criteria to evaluate the student’s achievement of the activity expectations.

Accommodations

- Teachers may provide differing levels of requirements for research, (e.g., could be more or less prescriptive in tasks, products could be prescribed or left open to proposals). Teachers may provide more direction to students in selecting and detailing assignments. Reporting formats and research reference requirements can be reduced or increased in scope and number to suit students’ abilities.
- Teachers ensure that students with disabilities have access to specific equipment and tools to perform required tasks (e.g., table-top power tools, simplified modelling/drawing equipment or resources).
- For enrichment, students consider mechanical or wide-ranging details (e.g., electrical, plumbing, structural elements, landscaping, costing, site planning, post-exhibition use).
- Base accommodations on student’s IEPs, where appropriate.

Resources

Print

Gordon, J.E. *The New Science of Strong Materials*. Markham: Penguin Books, 1978. ISBN 0-306-80151-5

Gordon, J.E. *Structures, or Why Things Don't Fall Down*. Markham: Penguin Books, 1978. ISBN 0-306-80151-5

Salvadori, M. *The Art of Construction, Projects and Principles for Beginning Engineers and Architects*. Chicago: Chicago Review Press, 1990. ISBN 1-55652-080-8

Norman, Donald A. *The Design of Everyday Things*. New York: Doubleday, 1988. ISBN 0-385-26774-6

Websites

International Database and Gallery of Structures (links, example structures) http://www.structurae.de/index_e.html

1964 New York World's Fair documentary – http://members.aol.com/bbqprod/bbqprod.html

1939 New York World's Fair – http://xroads.virginia.edu/~1930s/DISPLAY/39wf/front.htm

1967 Montreal World's Fair – http://naid.sppsr.ucla.edu/expo67/

World's Fairs and International Expositions – http://www.boondocksnet.com/expos/

World's Fairs and Expositions WebRing – http://members.spree.com/thearts/gbex/WebRing.html

Appendix 4-1A

Design Brief: World's Fair Pavilion

Situation
Our town has been declared the site of next year's World's Fair. The World's Fair is a major international exhibition; participating countries set up pavilions to display heritage and cultural artefacts as well as any state-of-the-art technical products they have developed and wish to promote.

To ensure Ontario building codes are met, participants must use Ontario architects to design, layout, and oversee construction of their pavilions. Your architectural firm is bidding on design contracts for various Asian, European and North African countries. Your group is responsible for developing one such bid.

Challenge
Research, sketch, plan, and build a model of a proposed pavilion for a participating country that represents and reflects that country.

Criteria and Constraints

- The client country must be thoroughly researched for established culture:
  - What symbols do they use?
  - How do they portray themselves to the outside?
  - What would they want to say about themselves?
  - What major economic products and services are available?
  - What previous World's Fair structures have they built (if applicable)?
- Initial sketches of your research and ideas must be prepared, reflecting:
  - identified 'themes' of the chosen country;
  - use of symbols and concepts;
  - initial ideas for the pavilion structure and interior layout.
- Presentation materials must include:
  - reports on construction methods to be employed to construct the pavilion;
  - ideas on what the structure may cost, (comparing different materials and building methods);
  - efficiency of construction (consideration of waste and environmental issues);
  - use cycle (i.e., what is done with the pavilion after the exhibition).
- Detailed presentation drawings are prepared, including:
  - information on scale;
  - exterior details;
  - complete interior layout.
- A scale model of the pavilion (use a 1 cm : 1 m scale) must be completed for the client presentation.
- Summary information outlines:
  - features of the proposed design;
  - research detailing your design decisions.
- All research references must be included.

Appendix 4-1B

Assessment/Evaluation Checklist for World's Fair Pavilion Design

Student:
Class:

Checklist for Pavilion Design	Level 1 limited	Level 2 adequate	Level 3 acceptable	Level 4 exceptional
Drawings conform to industry standards				
Drawings are accurate				
Drawings are clean and detailed				
Model quality and effort				
Models are accurate (scale)				
Models have required detail				
Considered site parameters				
Considered efficiency of construction (waste, etc.)				
Considered cultural symbols of country				
Considered overall theme				
Considered material properties				
Considered cost of materials and construction techniques				
Considered pavilion usage after exposition				
Considered eating function				
Considered rest functions				
Considered traffic patterns				
Considered engineering strength of structure				
Considered economy of materials				
Considered fire safety				
Considered mood				
Considered harmony/balance				
Considered focal point				
Considered pattern/rhythm				
Considered contrast				
TOTALS				
Level of Achievement				

Appendix 4-1C

Sample World's Fair Pavilion Rubric

Criteria	Level 1 (50 – 59%)	Level 2 (60 – 69%)	Level 3 (70 – 79%)	Level 4 (80 – 100%)
Knowledge/ Understanding Construction Process TFV.03, TF1.04, TF3.02, IC2.01	- demonstrates limited knowledge of construction processes, materials, and waste management	- demonstrates some knowledge of construction processes, materials, and waste management	- demonstrates considerable knowledge of construction processes, materials, and waste management	- demonstrates a thorough knowledge of construction processes, materials, and waste management
Thinking/ Inquiry Design TFV.01, TF1.01, TF2.01, TF3.02, SP1.01	- applies few of the skills involved in the design process	- applies some of the skills involved in the design process	- applies most of the skills involved in the design process	- applies all or almost all of the skills involved in the design process
Communication Drawing Conventions TFV.02, TF2.02, TF2.03, SPV.01, SP2.01	- 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 SPV.05, SP2.03, ICV.04, IC2.03	- 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.

Activity 2: Design of an Information Kiosk/Device

Time: 900 minutes

Description

Students design and build a full-scale prototype or finished product to display information in a public venue. Using the scenario of a temporary public event or permanent installation, students consider criteria such as material and structural properties, graphic design, environmental considerations, and client specifications in the design of an information kiosk or display system. Students are made aware of the design considerations and career opportunities in the multi-billion dollar trade fair and event display industry.

Strand(s) & Learning Expectations

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

Overall Expectations

TFV.01 - use the design process to create products or services based on an analysis of consumer needs and market requirements;
TFV.02 - follow Canadian Standards Association (CSA) drawing practices (e.g., using standardized symbols orthographic projection and applicable codes such as the Ontario Building Code, the Electrical Safety Code, and municipal by-laws) when creating drawings;
TFV.05 - determine project criteria and evaluate solutions to decide how well the criteria have been met;
SPV.01 - follow drafting conventions to produce technical drawings;
SPV.02 - analyse the physical characteristics of common building and manufacturing materials proposed for a design solution;
SPV.03 - produce technical reports and design briefs that follow a prescribed format;
SPV.04 - estimate the materials, fabrication, and labour costs associated with a project;
SPV.05 - build effective models and prototypes;
ICV.01 - identify concerns related to technical design, such as product safety, durability, costs, choice of materials, and ergonomics;
ICV.03 - describe liability issues that necessitate the inclusion of safety features in a product's design;
ICV.04 - follow safe operating procedures for tools and materials.

Specific Expectations

TF1.01 - evaluate consumer needs and expectations in relation to a specific product;
TF1.02 - evaluate the suitability of materials to meet the project criteria based on the materials' properties and costs, and on the manufacturing methods being used;
TF2.01 - apply the design process to develop solutions for a particular product or service;
TF2.02 - create technical drawings that reflect appropriate line type, weight, and density;
TF2.03 - use technical illustrations, drafting, computer graphics, and models to present ideas and solutions;
TF3.01 - identify, in technical reports, factors (e.g., materials, fabrication methods, trends, costs, ergonomics, alternative solutions) that influence design decisions for a particular product;
TF3.02 - evaluate solutions to ensure that project criteria are met;
SP1.01 - create effective design briefs that outline consumer needs and any other requirements or limitations that will affect the design solution;
SP1.02 - produce technical reports that follow a prescribed format;
SP1.03 - identify materials for particular projects based on desired physical properties using technical reference material such as *Machinery's Handbook, Sweet's Catalogue,* or *Architectural Graphics Standards*;

SP1.04 - determine whether proposed materials are suitable for a specific product;
SP1.05 - write effective technical reports that include sections such as the following: Design Brief, Criteria and Constraints, Idea Development, Planning, Design Analysis, Evaluation, Design Solution, Product Description;
SP2.01 - create accurate drawings (e.g., floor plans, perspectives and elevation views, section and assembly drawings) using both traditional (drafting board) and computer-based methods;
SP2.02 - estimate the costs of materials and fabrication methods for particular projects by performing quantity take-offs;
SP2.03 - fabricate models and prototypes following standard safety procedures;
IC1.01 - describe problems caused by improper or inadequate design;
IC1.02 - identify existing products that could be improved and explain problems in these products that resulted from inadequate design;
IC2.02 - describe safety issues, constraints, or legislation that would affect the design of a particular project and explain how these restrictions would affect design documentation and drawings;
IC2.03 - handle materials and tools safely.

Prior Knowledge & Skills

- Students should have a working knowledge of design problem-solving techniques gained through earlier activities. Students should have basic technical drawing, report writing, model fabrication, and presentation skills. Students should also have general computer skills such as Internet-based research, file manipulation, word processing, and graphic production.
- Students should have knowledge of general hand and machine tool safety requirements, though teachers should not assume safety familiarity. Safe operating procedures must be reviewed.

Planning Notes

- This activity continues from Activity 1: Design of Public Cultural Spaces. Teachers may adapt this activity to develop solutions to local community needs. Teachers may wish to pre-arrange community or industry representatives to present specific design challenges. Possible scenarios are:
  - malls;
  - schools;
  - cultural centres;
  - museums/galleries;
  - fairs/special events/seasonal events.
- This activity involves building full-scale mock-ups and finished (or components of finished) structures. Teachers should:
  - predetermine team size, which determines the number of products required;
  - determine available resources;
  - estimate the length of time available and storage space, during and after the activity.
- Teachers should provide images of example information kiosks or architectural signage structures or assign students to research commercial solutions. Teachers lead discussions on criteria for effective means of delivery messages and information (see Appendix 4-2B).
- The key to this activity is an analysis of current and historical practices in design of public spaces and information displays (e.g., signage and information kiosks). Analysing and critiquing existing work derives key concepts (see Resources). Analysing trends is vital to help students understand the historical progression of design ideas and the future of innovation. Example work should be gathered prior to implementing the activity.

- Teachers should review Unit 4 of the Grade 10 Technological Design profiles to prepare for instruction on types of structures (e.g., bridges, domes, towers, trusses, shells, geodesic domes, joist and beam frames, triangulated space frames, etc.). Existing commercial exhibition structures also should be examined.
- Material selection and investigations in material properties is an important focus of this activity. Teachers provide materials for construction of models, prototypes, and finished structures, which may include:
  - drawing and illustration tools and software;
  - cardboard sheets or boxes (e.g., moving or appliance cartons);
  - variety of wood materials, metals, plastics, structural foam, etc. as required;
  - duct tape, masking tape;
  - glue, screws, nails, or other fastening hardware;
  - finishing materials such as sandpaper, paints, varnishes, polishing waxes, etc. as required;
  - appropriate fabrication tools;
  - video/computer display or interactive elements as required;
  - safety equipment as required;
  - access to Internet and/or Library/Resource Centre research facilities.
- This activity integrates concepts and knowledge from Science, Social Sciences, Business, Mathematics, Creative Arts, and other technology courses. For example, mathematics is used for calculations of scale and geometry; science provides concepts in the physics of structures; social science or business for understanding culture and marketing; and art and technology for understanding graphic elements and communications technology. Understanding these concepts is essential to the process of effective and innovative problem solving. If a teacher is unfamiliar with previous learned skills or knowledge in any curriculum area, teachers from those areas should be consulted prior to implementing this activity.
- To initiate this activity, teachers should discuss criteria for assessment/evaluation and the specific requirements for successful solutions. See appendices for handouts detailing design briefs, design considerations, and reporting topics.

Teaching/Learning Strategies

Stage 1: Situation Analysis (approximately two periods)
The teacher initiates discussion of the particular situation students will develop solutions for. Teachers hand out materials outlining criteria for assessment/evaluation, specific requirements for successful solutions, format of research report, and research strategies. (See Appendix 4-2A –
Sample Student Handout.)
Students initiate a daily time log. Students individually research current and historical trends related to the given design problem. They individually report on design considerations, providing possible solution scenarios, in a written proposal and in discussions with the teacher. The written proposal is presented in a design brief format, including design sketches and analysis of possible solutions. The brief must include:

- an identification of health and safety issues related to the product, such as:
  - end user issues;
  - sharp edges;
  - falling or tripping hazards.
- ease of use and installers' and shippers' issues:
  - awkward or heavy lifting;
  - strong and rugged connections.
- a description of what would constitute bad or ineffectual design, accomplished through an examination of current or historical examples.

Students are then assigned design team tasks and responsibilities. Each team is allowed to proceed when the teacher is satisfied the task requirements are likely to be met through the proposed strategy.

Stage 2: Drawing, Modelling and Testing (approximately five periods)

- Students develop solutions through sketches, drawings, calculations, models, and material test pieces. Considerations include:
  - overall message and information to be conveyed;
  - specific client and situational requirements;
  - overall structural shape and size including structural modularity and assembly;
  - distance of visibility;
  - function of elements;
  - material properties;
  - shipping and assembly procedures;
  - component costs and economy;
  - manufacturing (custom or mass production);
  - safety and liability factors for installers and end users;
  - possible problems due to inadequacies or improper designs (both current products and proposed designs).
- Teachers assess and guide students on a daily basis. Teams advance to next stags on teacher approval.
- After selecting the preferred solution, students fabricate mock-ups with cardboard or other low-cost materials to test for design elements including: fabrication/assembly considerations, ergonomics, and anthropometrics (ease of use, relative heights, viewing angles, ease of controls, ease of assembly, and installation, etc.). Scale figures and eye-level photographs can be used to study scale and dimensions.
- People from the school community and/or clients are invited to review and comment on the intended solution. If a class solution is required, the class, in consultation with the teacher and clients or end users, discuss and decide on the elements of the final design. Teachers approve the design for advancing to the implementation stage.

Stage 3: Implementation (approximately six periods)

- Students are grouped into task teams to develop the proposed solution. Task teams are composed of:
  - technical drawing production;
  - cost and budget analysis;
  - prototype fabrication;
  - presentation material production (including 3-D modelling);
  - project management.
- Teachers ask students to present their progress at the beginning of each class. Project managers ensure that progress is maintained and that all teams have the necessary resources each day.

Stage 4: Post-implementation (approximately two periods)

Students complete an individual design report outlining their team and individual research and intermediate and final design features. Students include shared sketches, technical drawings, model photographs, etc., as well as their daily log of individual tasks. Teachers evaluate each student through individual and team consultation and presentation.

Assessment & Evaluation of Student Achievement

- Teachers assess daily, using criteria outlined in the evaluation rubric in Appendix 4-2B. Teachers evaluate each student's performance through a verbal presentation and the Engineering Design Report. The evaluation breakdown is as follows: 10% Design Brief; 20% sketches, models, test models; 30% completed prototype or model; 40% engineering report and presentation of work.
- Key assessment considerations are: demonstration of knowledge of a structured design procedure, knowledge and analysis of materials used in fabrication of the developed solution, and public safety and liability issues. See Appendix 4-2B – Sample Engineering Design Report for a rubric to evaluate the report/presentation. The daily log helps determine the individual student's achievement in team/group work.

Accommodations

- The expectations can be met through a range of solutions from simple signage (or series of signs) only requiring simple structural elements, to a fully interactive kiosk, requiring extensive user input and testing.
- Teachers may provide more guidance and assistance in design decision making, testing, analysis of material properties, and fabrication techniques. This may take the form of more directed research, additional resource materials, one-on-one assistance to complete assignment tasks, and/or peer assistance. Teachers may also provide additional assistance, peer assistance, and/or tutoring in fabrication activities.
- Extended challenges may be provided to enriched students by: requiring more complex research (e.g., research into corporate culture), in-depth cost analysis, project management, or in-depth material properties analysis. Multimedia productions, addition of sound, user interactivity, and coin-acceptance elements may add to the challenge for enrichment.

Resources

Books

Gordon, J.E. *The New Science of Strong Materials*. Markham, Ontario: Penguin Books, 1978.
ISBN 0-306-80151-5

Gordon, J.E. *Structures, or Why Things Don't Fall Down*. Markham, Ontario: Penguin Books, 1978.
ISBN 0-306-80151-5

Norman, Donald A. *The Design of Everyday Things*. New York: Doubleday, 1988. ISBN 0-385-26774-6

Salvadori, M. *The Art of Construction, Projects and Principles for Beginning Engineers and Architects*. Chicago: Chicago Review Press, 1990. ISBN 1-55652-080-8

Websites

Suggested keywords are "kiosk," "branding" or specific materials, such as "fibreglass" or "steel". Other sites specific to the project may be searched (e.g., world fairs, trade shows or local malls). General sites include:

Core77 Design Network, information on design careers, competitions, events - www.core77.com/

Feature Factory (Canadian) - http://www.fefa.com

International Database and Gallery of Structures (links, example structures) - http://www.structurae.de/index_e.html

Kiosk Design (portal site) - http://www.kiosk.org

Popular Mechanics, latest information on innovations and inventions - www.popularmechanics.com

Popular Science, latest innovations in industrial and architectural design - www.popoularscience.com

Appendix 4-2A

Sample Student Handout

Title: Design of a Public Information Display System
Activity: Students design and build a full-scale public information display system
Course: TDJ3M, Grade 11 Technological Design, University/College
Time Required: 15 periods
Date:

RATIONALE

"The medium is the message" is a famous quote from the late Canadian media expert Marshall McLuhan. How we present information is as important as the information itself. When we want to present information, directions, gather input, etc., we have to consider the symbolism inherent in materials, in size and shape, in types of display, in graphical design, as well as the information we wish to convey. In the multi-billion dollar trade fair and event display industry, the structures and sign layouts are important aspects of relaying information to the public. In this project, you develop an exhibition display system that takes into account: material properties; shipping, assembly, and installation issues; environment issues; display types; and end user/client requirements.

THE ASSIGNMENT

Design and build a full-scale structure to convey public information for a prescribed situation.

LEARNING EXPECTATIONS You will:

- identify end user and client needs;
- determine the criteria affecting design solutions;
- work effectively in a team environment;
- determine appropriate material properties for solutions;
- produce sketches, illustrations, and/or technical drawings as required for specific project needs;
- fabricate models, prototypes, mock-ups, and test models;
- test effectiveness of design solutions;
- produce engineering reports and presentations.

TOOLS AND MATERIALS

Illustration, sketching, drawing tools and materials, fabrication tools and equipment for metal, wood, plastics, etc. as required. Computer use: Internet research, CAD drawing, CNC/sign-making fabrication, illustration, 3-D modelling, word processing, and spreadsheet cost analysis.

EVALUATION

No.	Deliverable	Time Limit (periods)	Mark (%)	Notes
1	Design brief/proposal	2	10	
2	Sketches/models/test models	5	20	Evidence of research
3	Completed prototype	6	30	As directed by teacher
4	Engineering report/presentation	2	40	
	TOTALS	**15**	**100**	

Appendix 4-2A (Continued)

NOTES

Considerations in Design (identify and comment on each):

- End user requirements: message to convey; location; audience; theme; demographics
- Types of information displays: kiosks; signs; interactive; Point Of Sale (POS); indoor/outdoors; input/output sources
- Materials: symbolic meaning; (e.g., wood: nature, warmth, home)
- Materials: ease of manufacture; assembly; strength of structure; weathering; durability; vandalism; finishes
- Fastenings: ease of assembly; installation
- Shape/style: symbolism; location; size; use of colour/graphical elements; material and fastening considerations
- Safety: installers, public safety

PROJECT STEPS

Step	Student Activities
1	Stage 1: Situation Analysis (Individual) (approximately two periods) • Initiate log of hours. • Read design scenario. • Analyse requirements and research current solutions. • Develop list of design criteria. • List possible steps to develop solution. • Hand in personal Design Brief/Proposal.
2	Stage 2: Drawing, Modelling and Testing (Teams) (approximately five periods) • Discuss and brainstorm design criteria and possible solutions. • Develop sketches and models of possible solutions. • Choose appropriate design features for further work. • Develop mock-up, test for ergonomics, user survey comments. • Record all work and photograph all model work. • Retain materials for Engineering Report. • Seek teacher approval for continuation.
3	Stage 3: Implementation (Teams) (approximately six periods) • Determine team responsibilities and assign a Project Manager. • Fabricate structure and test structural strength, fasteners, finishes, etc. • Assemble and record.
4	Stage 4: Engineering Design Report (Teams and Individual) (approximately two periods) • Produce Engineering Design Report, ensure all format, headings, images, drawings, etc. are incorporated. • Present design features to class. • Hand in report.

Appendix 4-2B

Sample Design Brief

Scenario
[*Name of country*] is participating in the International World's Fair, to be held June 2004 in Ottawa, Ontario, Canada. [*Name of country*] is [*describe geographical location*].

The [*name of country*] Board of Trade has asked our firm to produce unattended information kiosk/display to provide people from around the world with information on the industries of [*name of country*], highlighting the kinds of products they produce for export. The goal is to encourage export sales and educate citizens from around the world on their economy and career opportunities. This information kiosk/display system is a component of their country's pavilion at the World's Fair.

Design Statement
Design a standalone information kiosk or display system for the Board of Trade of [*name of country*].

Considerations
You are to consider the *SUM* of this design:

SITUATION:	location, time, season, current practices, safety codes
USER:	intended audience, end user, customer
MESSAGE:	theme, clarity, utility, rationalization, symbolic intent

(The following to be identified in Proposal and Engineering Design Report):

- Client requirements: cost, space requirements, maintenance, durability, building codes, prefab elements, reuse (if applicable), and quick assembly/tear-down.
- End User requirements: message to convey, location, audience, theme, demographics.
- Types of information displays: kiosks, signs, interactive, POS, indoor/outdoors, input/output sources etc.
- Materials: symbolic meaning, e.g., wood: nature, warmth, home, etc.
- Materials: ease of manufacture, assembly, strength of structure, weathering, durability, vandalism, finishes etc.
- Identify and comment on your comparative evaluation of each of these materials, to be answered in the design brief.
  - Wood sheeting: Plywood, MDF, Masonite, Particle board.
  - Wood structural elements: fir, spruce, pine, maple, oak, others.
  - Metals: aluminum, steel, stainless steel, cold rolled steel, non-ferrous: brass, bronze, copper, etc.
  - Metal structural elements: sheet, tube (square, round), flat bar, castings.
  - Plastics: acrylic, Lexan, epoxy, fibreglass, vacuum formed, coatings, Coroplast (corrugated plastic sheet).
  - Other: glass, rubber, concrete, stone, virtual stone.
- Fastenings: ease of assembly, installation.
- Shape/style: symbolism, location, size, use of colour/graphical elements, material and fastening considerations.
- Safety: installation and assembly safety, public safety, safety legislation.
- Comparison of current designs, with a description on how they might be improved.

Appendix 4-2B (Continued)

Deliverables
We require the following:

1. Design Proposal: detailing research into [name of county]'s state of economics and exports; symbols, colours, and common themes of the country; considerations of design; possible solutions.

2. From there, we will be assembling design teams to:
   - sketch, illustrate, and model possible solution(s);
   - build and test full-scale mock-up for ease of assembly, scale, and ergonomics;
   - build full-scale prototype;
   - generate Engineering Design Report detailing design features and considerations.

Since the levels of government approval require an indeterminate time, we are asked to produce the package for our client in 15 days from today. *Please log your hours. We will bill client for time and expenses*.
Your job is evaluated through the completed project; criteria for your report are in the following rubric.

Appendix 4-2B (Continued)

Sample Engineering Design Report Rubric

Criteria	Level 1 (50 – 59%)	Level 2 (60 – 69%)	Level 3 (70 – 79%)	Level 4 (80 – 100%)
Knowledge/ Understanding Knowledge of facts, technical terminology, procedures, and standards to be used in a technical drawing. TFV.02	- demonstrates limited knowledge of facts, technical terminology, procedures, and standards to be used in a technical drawing	- demonstrates some knowledge of facts, technical terminology, procedures, and standards to be used in a technical drawing	- demonstrates considerable knowledge of facts, technical terminology, procedures, and standards to be used in a technical drawing	- demonstrates a high degree of knowledge of facts, technical terminology, procedures, and standards to be used in a technical drawing
Understanding of design concepts. SP1.03	- demonstrates limited understanding of design concepts	- demonstrates some understanding of design concepts	- demonstrates considerable understanding of design concepts	- demonstrates thorough understanding of design concepts
Thinking/ Inquiry Inquiry/design skills TFV.01, TFV.05, TF1.01, TF1.02, TF2.01, TF3.02 SPV.02, SPV.04, SP1.04, SP2.02	- applies few of the skills involved in an inquiry/design process	- applies some of the skills involved in an inquiry/design process	- applies most of the skills involved in an inquiry/design process	- applies all or almost all of the skills involved in an inquiry/design process
Communication Use of language and symbols on technical drawings TF2.02, TF2.03, SPV.01, SP2.01	- uses language, symbols, and visuals with limited accuracy and effectiveness on technical drawings	- uses language, symbols, and visuals with some accuracy and effectiveness on technical drawings	- uses language, symbols, and visuals with considerable accuracy and effectiveness on technical drawings	- uses language, symbols, and visuals with a high degree of accuracy and effectiveness on technical drawings
Application Use procedures, tools, and equipment safely SP2.03, ICV.04, IC2.03; ICV.01; ICV.03; IC2.02	- uses procedures, equipment, and technology safely and correctly only with supervision	- uses procedures, equipment, and technology safely and correctly with some supervision	- use procedures, equipment, and technology safely and correctly	- demonstrates and promotes the safe and correct use of procedures, equipment, and technology

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