Public District School Board Writing Partnership

Course Profile

Integrated Technologies

Grade 9
Open

· *for teachers by teachers*

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Acknowledgments

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Unit 3: Construction and Technological Design

Time: 22 hours

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Development Date: July 1999

Unit Description

Students investigate four different activities covering many aspects of Technological Design and Construction Technology, as well as the integration of computers into each activity. Although activities may be delivered independent of each other, skills developed in each activity contribute to the next activity in the unit. Students apply problem-solving models to the various challenges, and at the end of the unit have produced four products or services. Students have the opportunity to become aware of career opportunities, education programs, and opportunities for co-operative education, community resources, and safety issues as they apply to technological education and computers.

Strand(s) and Expectations

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

Overall Expectations: TFV.01X, TFV.02X, TFV.03X, SPV.01X, SPV.02X, SPV.03X, SPV.04X, SPV.05X, ICV.01X, ICV.02X, ICV.04X, ICV.05X.

Specific Expectations: TFS.01X, TFS.02X, TFS.03X, TFS.04X, TFS.05X, TFS.07X, SPS.01X, SPS.02X, SPS.03X, SPS.04X, SPS.05X, SPS.07X, SPS.08X, ICS.01X, ICS.02X, ICS.03X, ICS.04X, ICS.07X.

Activity Titles (Time + Sequence)

Activity 1	Manufacture Wooden Clothing Accessories	300 minutes
Activity 2	Designing a Folding Chair	300 minutes
Activity 3	Railway Crossing Lights	320 minutes
Activity 4	Millennium Time Capsule	400 minutes

Unit Planning Notes

Before initiating each of these activities, teachers should secure the appropriate resources and work through each activity prior to implementation. These preparations ensure that all facility, equipment, and material requirements are met. Some activities require the teacher to research new information. Students and teachers benefit from contacting local businesses in the design and construction industry for support in conducting the various activities. These members of the community also provide students with insight into career opportunities, educational requirements, and, potentially, offer students co-operative education learning opportunities in Grades 11 and 12 in the design or construction sector of the economy.

Prior to the beginning of each activity teachers need to obtain the following: pencil, eraser, graph paper (150mm x 450mm), rigid paper for finished pattern, ruler or tape measure, straight edge, scissors, utility knife, wood, thickness planer (desirable but not essential), band saw, scroll saw, drill press, sand paper, files, chisels, hammer, white glue, paint, wood stain and finish, paint brushes, clamps, spray-grade contact cement (or a water soluble substitute), fabric, braided elastic, masking tape, word processor, Box board, Bristol board, scissors and masking tape for the modelling phase of this project, as well as an overhead projector. Additional materials to enhance the modelling phase include coffee stir sticks, scraps of wire (with wire strippers and pliers), thumbtacks, glue, straws, elastic bands, string, fabric scraps, wood scraps, etc. A full prototype of the project may be made with manual or power tools, depending on the technological facility available. Additionally, drawings may be done using computer-aided design (CAD) applications (prior CAD instruction is required). Suggested material for the construction of the time capsule include: plastics, wood, metals, or recycled materials, all modelling materials, small wire, solder, soldering irons, safety glasses and wire strippers, plastics, wood metals, recycled materials, artifacts that students choose, Bristol board, wood, scissors, masking tape, coffee stir sticks, scraps of wire, thumbtacks, glue, straws, elastic bands, string, fabric scraps, wood scraps, etc.

Prior Knowledge Required

By Grade 8, students have learned to communicate procedures and results of investigations including original ideas for specific purposes and to specific audiences. Students communicate using a variety of mediums, including written notes, drawings, specifications, and oral presentations. Students are aware of basic safety precautions for using hand and machine tools.

Teaching/Learning Strategies

This unit incorporates a variety of teaching and learning strategies, including: teacher-directed activities, individual learning activities, group work, and co-operative learning strategies. The teacher should provide the students with the information, resources, and guidance necessary to complete each task safely and with maximum opportunity for success. Provide students with opportunities to work independently and in groups to perform the following tasks: problem solving, brainstorming, safely using hand and power tools, following various design processes, (see Appendix 1), collecting information, report writing, assessing and evaluating projects, and making classroom presentations. Activities should be modified to meet the needs of all learners by applying various accommodations, such as: allowing increased time for activities, enhancing or compacting course content, assisting during evaluation processes, and facilitating peer - tutor assistance where possible. Teachers supervise students' safe operation of only those hand and power tools that they (the teachers) themselves are skilled at using safely. If a teacher is uncertain about the correct use of equipment, then an alternate activity should be selected for students.

Resources

Books

Huchinson, J. and J.R. Karsnitz. *Design and Problem Solving in Technology*. ISBN 08-8273-5246-8

Tokeim, Roger. *Digital Electronics*. ISBN 0-07-064980-4

Caney, Steven. *Make Your Own Time Capsule*. 1992. ISBN 0894804189

Packard, Mary and Brian Floca. *Make Your Own Time Capsule*. Troll Assoc., 1999. ISBN 0816749760

Web Sites

http://205.181.179.43/fw/

http://www.augusthome.com/woodsmith.htm

http://www.time-capsule.com

http://www.futurearchaeololgy.com

http://www.mindspring.com/~futurepkg/indes.htm

Software

Electronic Workbench. Ministry of Education and Training School Licensed Software
http://www.cadsoftware.com/

Activity 1: Manufacture Wooden Clothing Accessories

Time: 300 minutes

Description

Students follow a design process to create a wooden clothing accessory such as a necktie, scarf, belt, headband, etc. The selected item is designed for someone specific, such as a parent, guardian, relative, friend, coach, or the students themselves. Students may make the object for someone from another culture, thereby broadening their perspective and potentially increasing their sensitivity to issues of bias. The item should also reflect the recipient's personality, job, hobby, or culture.

Strand(s) and Expectations

Strand(s): Theory and Foundations, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.03X, SPV.01X, SPV.03X, SPV.04X, ICV.01X.
Specific Expectations: TFS.01X, TFS.03X, TFS.04X, SPS.01X, SPS.04X, SPS.07X, SPS.08X, ICS.01X, ICS.03X.

Planning Notes

Before attempting this activity with a class, teachers experience the complete process of designing and manufacturing at least one wooden clothing article to be used as a sample to motivate students. Required materials and equipment include: pencil, eraser, graph paper (150mm x 450mm), rigid paper for finished pattern, ruler or tape measure, straight edge, scissors, utility knife, wood (pine and butternut preferred), thickness planer (desirable but not essential), band saw, scroll saw, drill press, abrasive paper, files, chisels, hammer, white glue, paint, wood stain and finish, paint brushes, clamps, spray-grade contact cement (or a water-soluble substitute), fabric, braided elastic, masking tape, and a word processor.

Prior Knowledge Required

By Grade 8, students have learned to communicate procedures and results of investigations including original ideas for specific purposes and to specific audiences. They communicate using a variety of mediums, including written notes, drawings, specifications, and oral presentations. Students demonstrate an awareness of basic safety precautions for using hand and machine tools. If the students cannot demonstrate this knowledge, review all pertinent safety lessons.

Teaching/Learning Strategies

Students consider the individual who will wear the article. Teachers help students recognize ways in which individuals assume identity (often through a career, culture, favorite sport, hobby, or family responsibilities). Criteria for the project include the recipient's physical stature, the number of sections in each article, wood types and texture, wood working techniques such as marquetry (inlaid work of wood often interspersed with decorative objects such as stones) and inlay, and types of finish such as natural, stain, or paint. Students retain all of their project sketches and patterns to hand in at the end of the activity. These sketches and patterns are included as part of the assessment criteria.

Teachers ensure students follow the design process (see Appendix 1), and prepare thumbnail sketches and a comprehensive pattern for their final designs. Teachers accommodate various learning abilities by expanding or eliminating stages of the design process. For example, rough sketches may be omitted for learners who may not possess the skill of positive self-criticism, thereby making design development difficult.

Teachers enhance the learning activity by allowing students to create computer-generated graphics such as *CorelDRAW*™ as well as or instead of creating hand drawings. Students must know proper procedures to follow when using drafting tools, computers, planers, band saws, scroll saws, drill presses, sanders, and hand tools.

Teachers review all appropriate safety precautions before allowing students to use hand and power tools. For example, teachers emphasize the importance of having only one operator on each machine at any given time, as well as the need for careful supervision and to ensure all guards are in place. Safety glasses must be worn and loose clothing or hair must be secured or fastened while students operate tools or equipment. Hand tools and machinery must never be handled in a seated position. Students should establish a proper stance to ensure proper balance and stability while operating any piece of equipment. Students with physical disabilities and those who require crutches or a wheelchair require special consideration and should be accommodated on an individual basis according to their limitations. Each piece of equipment and machinery must be in top running condition before anyone is allowed to operate it. Horseplay is not acceptable in a technological facility at any time.

Activity Instructions

Students write (or word process if possible) a proposal for the article of wooden clothing and format the proposal as a business memorandum addressed to the teacher. The proposal identifies the person to receive the article (mentioned in the description) and explains the skills and knowledge required to complete the project.

Students prepare several thumbnail sketches for different designs. Students draw the full-scale design on pattern paper using drafting instruments to maintain proportions. Students choose at least four breaking sections to provide flexibility in the wooden piece of clothing.

Students cut the full-scale pattern and select a piece of pine to be planed down to 6mm on the thickness planer. Students trace the main body of the clothing pattern including the break sections onto the pine. (The knot and additional feature sections of a tie may be traced onto a piece of 10mm butternut to create

contrast and an additional 3D effect - oak, walnut, cherry, or other dark woods can be used instead of butternut.)

Students cut their wood to shape with a bandsaw. Internal cuts require the use of the drill press followed by the scroll saw. Students who are intimidated by these machines require additional encouragement and supervision to complete tasks. These students usually appreciate their new skills after successfully completing several operations.

Students making a tie drill a hole through the top section of the knot to accommodate the elastic.

Students shape the edges and surfaces of their pieces using files and sand paper, starting with coarse grades and finishing with a fine grade. Teachers provide special instructions to assure students understand to sand in the direction of the grain and to remove all scratches and machine marks.

Students select paints or finishes desired to finish their project and apply them using proper techniques. The articles are stored for drying. Immediate and conscientious cleanup is required to properly maintain paints and brushes.

Students invert and assemble the sections of the clothing article by running masking tape around the perimeter of the whole unit (for example, around the whole tie). The tape covers only 6mm of the edge and hangs over the edge to protect the finish surface from overspray of the contact cement (or other spray adhesive). Students do not place any tape along the section joints.

Students cut an oversized piece of fabric and place it face down on a large piece of scrap paper beside the wooden clothing article. Students apply a thin even coat of contact cement to both surfaces and allow the adhesive to dry for approximately 10 to 15 minutes. This is done in a well-ventilated area, as some people are sensitive to the fumes of contact cement. After the contact cement has dried, another student or the teacher stretches the fabric, while students invert the wooden clothing article onto the fabric, causing the two surfaces to adhere. Students then press the fabric with their fingers to ensure that the entire surface has made full contact. Students trim the fabric with a sharp utility knife by following along the inside edge of the tape. Students peel away excess tape and fabric. The article of clothing is fitted to the model.

Students complete finishing touches or repairs as required.

Students use a rubric to evaluate their article of clothing, comparing all design elements with the original pattern, checking on finish sizes, quality of construction, and quality of finish. Teachers may enhance the learning process by allowing some students to design their own rubric to assess their article and determine if it met the planned design criteria.

Students produce a design report, including all sketches, drawings, and comprehensive patterns used to make their article, plus a description of the method used to create the piece and evaluations of the project design and process.

Assessment/Evaluation

Students demonstrate appropriate use of computers and save their work successfully. The proposal is in correct format and includes the project proposal and the knowledge and skills students are expected to learn. Students produce several different ideas as thumbnail sketches. All thumbnail sketches meet the specified criteria and correspond to the students' proposals. Students' demonstrate appropriate use of drafting instruments and reproduce their work successfully. Students' critiques demonstrate careful thought (something more than "I can't think of anything else"). Graphs and patterns show development and refinement of design ideas. Patterns are neatly and carefully cut out, assuring an accurate template for the finished project.

Students demonstrate proficient and safe use of machinery through proper set-up, use of eye protection and push sticks, and proper use of guards. The use of relief cuts is also necessary when cutting irregular

lines. Material is properly prepared before finishing. Students check all surfaces for machine marks, rough or sharp edges, and gouges or scratches. All surfaces are smooth and all edges are rounded and comfortable to the touch. Break lines in the wooden clothing article are strategically placed in order to enhance the aesthetic design. Students assure the finish is applied completely and evenly on all exposed surfaces of the wooden clothing article and all paints and brushes are properly cleaned and stored after use. Teachers assess that the Project Report includes the thumbnail sketches, scaled drawings, patterns, description of the steps used to fabricate projects, evaluations of project designs and processes, and self-evaluation rubrics. Students produce reports using word processing programs and ensure they are correctly formatted. Students complete self-assessments fairly.

	Level 1	**Level 2**	**Level 3**	**Level 4**
Knowledge/ Understanding TFV.01X TFV.03X TFS.01X TFS.04X	- demonstrates limited knowledge of types of wood, technical terminology, procedures, and standards	- demonstrates some knowledge of types of wood, technical terminology, procedures, and standards	- demonstrates considerable knowledge of types of wood, technical terminology, procedures, and standards	- demonstrates thorough knowledge of types of wood, technical terminology, procedures, and standards
Thinking/Inquiry SPV.01X SPV.03X SPS.01X SPS.07X	- 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 SPV.04X SPS.04X TFS.03X	- communicates information with limited clarity	- communicates information with some clarity	- communicates information with considerable clarity	- communicates information with a high degree of clarity and with confidence
Application SPS.08X ICV.01X ICS.01X ICS.03X	- 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

Accommodations

Teachers may provide sample patterns of wooden clothing accessories for students who experience difficulty visualizing a pattern. A Project Design Report template created on any word processor or spreadsheet helps students write a report by providing them with prepared blanks to fill in. Partners may help visually-impaired students with more complicated tasks such as cutting irregular shapes on the band saw. Visually-impaired students may use wax-coated string to create their pattern outline on paper and have their partner cut it out with scissors. The student then transfers the outline onto the wood piece by tracing the outline with a pencil. Very closely supervised by the instructor, the student may be able to cut some of the simpler cuts on the band saw while the partner completes the more complex cuts. Visually-impaired students may always do their own shaping and sanding since they can feel the texture of the material. To extend activities, teachers may allow students to design more complex components for their wooden articles, requiring them to learn about additional machines such as the lathe or learn about different techniques such as marquetry and inlay.

Resources

Books

Hutchinson, J. and J.R. Karsnitz. *Design and Problem Solving in Technology*. ISBN 08-8273-5246-8

Magazines

Woodsmith

Fine Wood Working

Wood

Web Sites

http://205.181.179.43/fw/

http://www.augusthome.com/woodsmth.htm

Catalogues

Lee Valley Tools

Activity 2: Designing a Folding Chair

Time: 300 minutes

Description

Students, working in pairs, follow the outlined process to design and construct a scale model and, if possible, a prototype of a folding chair. The chair, when folded, must fit under a bed for storage. Students research suitable and comfortable chair sizes by assessing and measuring their classmates' chair requirements. They obtain anthropological information, create orthographic and isometric drawings of the chair, write a design report, and present their project to the class.

Strand(s) and Expectations

Strand(s): Theory and Foundations, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.02X, TFV.03X, ICV.01X.
Specific Expectations: TFS.01X, TFS.03X, TFS.04X, SPS.07X, SPS.08X.

Planning Notes

Teachers require boxboard, Bristol board, scissors and masking tape for the modelling phase of this project, as well as an overhead projector. Additional materials to enhance the modelling phase include coffee stir sticks, scraps of wire (also wire strippers and pliers), thumbtacks, glue, straws, elastic bands, string, fabric scraps, wood scraps, etc. A full prototype of the project may be made with manual or power tools, depending on the technological facility available. This activity provides a good introduction to drafting skills using the drafting board and pencil. Additionally, drawings may be done using computer-aided drafting (CAD) applications (prior CAD instruction is required).

Prior Knowledge Required

By Grade 8, students have learned to communicate procedures and results of investigations for specific purposes and to specific audiences using a variety of mediums, including written notes, descriptions, drawings, and oral presentations. Participants must demonstrate safe use of tools and equipment. Students may require instruction in computer applications such as computer-aided drafting and word processors.

Teaching/Learning Strategies

1. Teachers outline the scope of the project with students.
2. Students brainstorm about desirable characteristics of folding chairs. Teachers may wish to list the desirable characteristics for the class to share, after the brainstorming session. (e.g., it is desirable for a folded chair to fit under a bed for easy storage).
3. Students measure classmates' chair requirements in millimetres and then find the averages for individual requirements. For example, students measure the height from floor to seat for a range of comfortably seated individuals and then calculate the average floor-to-seat height.
4. Students make paper shapes of people in average sizes at a scale of 1:5. Average sizes have been obtained by measuring volunteer classmates. (The teacher may have a sample pattern to share with the class).
5. Students place the paper shapes in various poses resembling a human sitting, to obtain information about angle of back, distance from floor to seat, etcetera.
6. Individually, students sketch their chair design ideas and then share these ideas with each other. In partners, students reach agreement about the proposed appearance of their chair and complete a composite sketch together.
7. Students begin to construct the chair using building materials. The teacher acts as a facilitator and ensures safety rules are being followed.
8. Students explore methods of hinging and supporting the chair, with advice and support from the teacher.
9. Students create orthographic drawings - first not-to-scale, then in 1:5 scale or 1:10 scale.
10. Students add dimensions to their drawings following the teachers instructions.
11. Students create isometric sketches of the complete chair.
12. The creators present their projects to the class.

Activity Instructions

Teachers ask students to imagine they have a small room, and that this room is the only place where they can entertain friends. During the subsequent discussion, it becomes clear that small spaces only allow for a limited number of furniture pieces and it is likely that visiting friends would end up sitting on the bed and floor. Students discuss how to provide enough furniture to seat visitors comfortably and yet keep the room free of clutter when there are no visitors. A practical, attractive solution is to provide a comfortable chair that can be folded and stored under the bed when not needed.

1. Students brainstorm about types of folding chairs and describe related mechanisms. For example, students discuss how lawn chairs fold and how wheelchairs fold. Teachers encourage them to recognize that folding chairs can also be designed to come apart for easy storage and transportation. Teachers may wish to show pictures of folding chairs or bring actual folding chairs to class to spark discussion.
2. Teachers introduce the topic of anthropometrics by asking students to think about people's range of sizes - large, medium, small, and variations between. (Since teenagers can be particularly sensitive about how they appear to each other, potential negative statements about weight and height, whether or not intended, can be avoided by focussing the discussion on well-known athletes, performers, or newsmakers). Students consider clothing sizes and the fact that they may own a range of clothing sizes (for example, some medium and some large). Students discuss why clothing sizes are not consistent and how clothing designers decide to assign sizes. Students speculate about chair sizes and how chair designers know where to position armrests, where to locate seats in relation to the floor, and how to angle seat backs.
3. The class discusses ergonomics and considers the characteristics of a comfortable chair. Students assess the chairs they are currently sitting in for comfort, leg room, thigh support, etc. The group considers that the clothes they wear and the furniture they sit in are made for average-sized people. Four volunteers from the class are measured. A student records the values on a chart, noting the tallest girl and boy and the shortest girl and boy. Other students average the sizes. All partners write the averaged values in their log books. The group should discuss if a sample of four is sufficient to obtain an average size.
4. Using the average sizes and a 1:5 metric scale, students draw lines to the appropriate lengths on a piece of scrap paper, leaving lots of space around each line. Students draw a body around the lines (head and torso, upper arm, lower arm and hand, thigh, and lower leg with foot). Students cut the paper patterns, trace these patterns onto Bristol board, add space around joint areas so that brass fasteners can be inserted later, and cut out the shapes of different body parts. The body part shapes are connected with fasteners (bent paper clips may also be used to allow pivotal action).
5. The teacher poses a Bristol board person on an overhead in positions ranging from upright to reclining, projecting the figure onto a wall. The class discusses the notion of comfort and determines what is a comfortable sitting position. A line is drawn on the overhead to indicate floor level. The Bristol board model's feet are placed against the line and a measurement from the floor to the bottom of the seat is made. This measurement determines the length of the chair legs. The teacher traces the angle of the seat, removes the Bristol board model, and shows how these lines can be interpreted as a chair. Using the same method, students determine the appearance of their chair by posing the Bristol board models on paper and making similar measurements.
6. Teachers and students brainstorm about the notion of "hinging" the chair designs. Students draw their ideas for hinges on the board or overhead. Students consider how they will make their chairs fold.
7. Students create a model of their design by cutting out panels for chair seats and backs from a material such as cardboard. A wide variety of building materials should be available. Legs may be constructed out of cardboard, straws, stir sticks, wire -- anything handy. Students are discouraged from using ready-made building materials, such as Lego or Meccano. Ready-made materials will not provide the sizes needed to fit the cardboard figures. Teachers remind students that while the chair has to fold, it also has to stay upright. Areas where the chairs could fail are pinpointed and students determine if they need to include support for the legs and backs.

8. Teachers demonstrate orthographic drawing of the chair to prepare students for creating their own 1:5 or 1:10 scale to fit the drawing on a B-sized sheet. Students select a suitable scale. The drawing is dimensioned.
9. Teachers demonstrate isometric sketching of the chair to prepare students for creating their own not-to-scale isometric drawing. Iso paper is used, when available.
10. Students present chair, paper person, isometric and orthographic drawings to class.
11. Students provide feedback to each other about their presentations. (See the following feedback sheet.)

Accommodations

Because this is a paired activity, teachers can select a partner with strengths to balance the special needs of some students. Changes are possible to any or all of the activities associated with the stages of the design process. Students with varying artistic skills, for example, could decorate their Bristol board person or chair model. If partners are encouraged to divide the work equitably, a student who prefers building to designing will be accommodated. The use of isometric paper greatly aids the student in visualizing isometric projections. As an enrichment activity, students may use a computer-modelling program to represent their design ideas, or be challenged to have the chair serve more than one purpose (e.g., it floats, it can be a bed). Other accommodations within this activity may include: simplified or expanded research, adjusting the modelling medium (paper, plastic, wood, ferrous and non-ferrous metals, etc.), in-class peer tutors familiar with the technical processes, extra time provided after school or at lunch.

Assessment/Evaluation

Design a Chair - Student feedback regarding the presentation (comments only, no marks)

Names of presenters:
Was the presentation audible?
Was the presentation sensible?
Did the presenters demonstrate how the chair folds?
Did the presenters speak enthusiastically about their chair design?
What were some of the positive qualities described to you?
What suggestions would you make to the presenters to improve the presentation?

Design a Chair - Marking Scheme

Names of Partnership: _____

Criteria/Comments/Mark

1. Make a cardboard person at a scale of 1:5, based on the averaged sizes of the class.
    - overall height correct
    - conform to the measurements found in class
    - proportion of person appropriate /5

2. Sketch chair using isometric projection methods.
    - iso paper used
    - followed the three axes
    - proportion good
    - neatly done, line work clear and visible
    - title block lettered /5
3. Create an engineering drawing using orthographic projection methods.
    - three views properly oriented
    - to scale (1:5 or 1:10)
    - dimensions included
    - neatly done, line work clear and visible
    - title block lettered /5
4. Make a model of your design, using a scale of 1:5.
    - chair must fit person
    - chair is neatly built
    - chair must not collapse
    - chair must fold, and fit under bed
    - obvious thought put into design /10
5. Present your chair to the class.
    - introduce self and partner
    - show person and chair
    - demonstrate how the chair folds
    - tell us something unusual or positive about your chair
    - show us the drawings of your chair
    - answer questions from audience
    - presentation was audible
    - presentation was upbeat and enthusiastically done /5
6. Complete a technical report about the chair project. Complete a group and self-evaluation.
    - report is neatly presented
    - report has illustrations
    - report is free of spelling and grammar errors
    - report covers all major aspects of project
    - evaluation complete /10

Assessment Rubric				
	Level 1	**Level 2**	**Level 3**	**Level 4**
How to develop products or provide services: TFV.01X, TFS.01X	- limited ideas generated	- some ideas generated	- generated many original ideas	- generated many creative ideas
Communicates through a variety of media: TFV.02X, TFV.03X	- drawings completed with full assistance - presentation made with limited clarity - technical report partially completed	- drawings completed with some assistance - presentation made with moderate clarity - technical report contains some components	- drawing is complete and dimensioned, line work follows required format - presentation audible, content is appropriate - technical report contains all required elements	- drawing is complete, dimensioned, line work is neat and precise - presentation is engaging - technical report is thorough in scope, neatly illustrated
Evaluates project work TFV.03X, TFS.04X	- chair does not fold - chair does not fit under bed - chair will collapse when used - chair is not to size (does not fit person)	- chair folds - chair may jam when fit under bed/just fits under bed - chair will collapse when used - chair back may collapse - chair legs may splay - chair model is not stable	- chair folds - chair fits under bed - chair model is stable - chair back is supported, legs will not splay - chair fits person, but may have pressure points	- chair folds into required size - chair is comfortable, and supports person - chair model is stable
Fabricate product using design process and tools SPV.01X, SPS.01X, SPS.07X, SPS.08X	- model construction is limited	- model adequately constructed	- model neatly constructed	- model well constructed and decorated
Safety ICV.01X	- needs reminders to act in safe manner	-needs some reminders to act in safe manner	- acts in safe manner	- demonstrates and encourages safe work habits

Chart used to record sizes of students, and final average size. The average sizes must be recorded by every partnership. They are used to size the person:

	Back to Hip	Hip to Knee	Knee to Floor	Shoulder to Elbow	Elbow to Wrist
Student 1					
Student 2					
Student 3					
Student 4					
Averages					

Activity 3: Railway Crossing Lights

Time: 320 minutes

Description

Students apply a design process to research and develop a working model railway signal device. The device incorporates electricity, digital electronics, structures, and mechanical systems. In a modified version of the activity, students may create design solutions for a wide variety of required signal devices such as model traffic lights, warning lights, or lights to enhance a graphic display such as a sculpture.

Strand(s) and Expectations

Strand(s): Theory and Foundations, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.03X, SPV.03X ICV.04X, ICV.01X.
Specific Expectations: TFS.07X, SPS.01X, SPS.01X, SPS.03X, SPS.04X, SPS.08X, ICS.01X.

Planning Notes

Teachers gather all modelling materials for the structure and mechanisms in the signal device. Gather the following required components: prototype board for electronic circuits, 555 IC timer, two 24-k ohm resistors, 10 MFD capacitor, coloured light-emitting diodes, and two - 330 ohm resistors. Local hardware stores can provide the following other required materials and tools: small wire, solder, soldering irons, safety glasses and wire strippers.

This activity emphasizes digital electronics. Teachers may also focus on other technological processes depending on student knowledge and available facilities. Students create an electrical circuit that produces a digital signal. Students research structural, mechanical, and electrical requirements of the railway signal device (or equivalent system). Students also identify design criteria for creating a safe structure and mechanism, a reliable mechanism and electronic circuit, and an effective means of signaling. Working through all design stages (see Appendix One) outlined in the activity instructions, students develop a suitable structure and mechanism for their signal device. Students also design and install one or more digital signal lights in this device. The frequency of the flashing signal light may be altered to fulfill a variety of applications. Students view an ideal example of this on/off action when they witness a digital device in a familiar application - the railway crossing light. Students become acquainted with the decimal system in which all numbers are to the power of ten. In these digital systems, where numbers are to the power of two, students soon realize there are only two possible conditions - the digital circuit only produces an on or off sequence. In later activities, this digital circuit can be used to drive binary counters or clocking systems. An integrated chip (IC) produces a signal by using a resistor/capacitor combination to produce the desired frequency of the output pulse. Enlarging either resistors or the capacitor increases the on/off

time or slows the rate of flashes. The output on the chip is from pin number three. This location is where a light-emitting diode with resistors connected in series may be used to change the electrical signal to a light signal. If suitable for the signal device being designed, an eight-OHM speaker can be used to change the electrical signal into a sound. Operating on five volts DC, this circuit uses little electrical energy and results in the project being safe and efficient. The IC in this circuit can operate on a nine-volt DC battery, however the resistor values must change to maintain the same pulse rate. Electrical components of the pulse generating circuit are small. Students must understand that precision in installing these components and soldering leads requires patience and a steady hand. As this may be the first circuit many students have built, they must pay close attention to detail if they are to achieve success. Key safety considerations in constructing electrical circuits are: Safety glasses must be worn at all times while using hand and power tools. Lead solder (if used) can be dangerous. All students should wash their hands after handling solder. Soldering must be done only over a fire-resistant surface. Teachers must check all circuits before energizing to ensure no components are damaged and there is no danger to participants. Students must work in a professional, appropriate manner while operating tools and working in a technological facility. Inappropriate behaviour will not be tolerated, particularly in a technological facility environment.

Prior Knowledge Required

Students have learned to communicate procedures and results of investigations including original ideas for specific purposes and to specific audiences using a variety of mediums including written notes, drafting skills, specifications, and oral presentations. Students have received an introduction to the design and construction of a variety of electrical circuits and investigated ways in which electrical energy is transformed into other forms of energy. Students are aware of basic safety precautions and correct usage of hand tools.

Teaching/Learning Strategies

Teachers begin this activity by discussing the history of electronics in relation to the transportation sector of our society, and the profound influence of electronics. The discussion may include comparisons from the past of a conductor waving a coal oil lamp to the advent of the tube radio and to today's proliferation of tiny ICs within two-way radios, switching devices, and monitoring engine controls in virtually all vehicles. Students engaging in the design and construction of a model signal device become more aware of the impact of computer technology and digital controls in the transportation sector and society as a whole.

Activity Instructions

Teachers present the train signal challenge and explain that a goal of the activity is to help students integrate a digital control circuit into a system. The specific design stages students work through depend on the emphasis in the activity. This activity focuses on the electronics aspect of the solution and the design of the functional circuit. However, students with more experience in fundamental electrical and electronic control may undertake greater challenges by enhancing the complexity of the circuit to utilize a motor control circuit. The motor control circuit actuates the train signal arms at the same time as the digital flasher.

As part of the electronics component, students install a 555 IC timer into a small prototype circuit board. A dot or "c" shaped mark on the IC indicates the left side of the computer chip. Pin one is in the left-hand corner. The pins are labeled from pin one in a clockwise direction, with pin four in the bottom right corner, pin five in the top right corner, and pin eight in the top left corner.

If a prototype board is not available, an eight-pin IC socket can be used by soldering components to the socket leads, and then inserting the IC at the last step. Students follow this sequence:

Connect pin one to ground or negative. Connect pins eight and four to +5 volts DC.
Install a 24-k ohm resistor between pins eight and seven.

Install a 24-k ohm resistor between pins seven and six.
Connect pin two to pin six.
Install a 10 MFD capacitor between pins one and two (negative side of the cap must be on pin one).
Connect pin three to both the light-emitting diodes (LED), the cathode or flat side of one LED and the anode or positive side of the other LED.
Solder a 330-ohm resistor to the other lead of each LED.
Connect one resistor to the positive (+5vdc) and the other resistor, which is soldered to the cathode of the LED, goes to the ground or negative lead.

The above sequence of operations allows the LEDs to continually flash at a set interval. Students may then incorporate this functional digital circuit into their railway signal device (or other system). Simple techniques to customize the above circuits to various signal devises include providing additional lights and switches, and alternating the LED colours.

Assessment/Evaluation

	Level 1	Level 2	Level 3	Level 4
Knowledge/ Understanding TFV.01X	- demonstrates limited understanding of concepts	-demonstrates some understanding of concepts	- demonstrates considerable understanding of concepts	- demonstrates thorough and insightful understanding of concepts
Thinking/Inquiry TFV.03X	- uses thinking skills with limited effectiveness	- uses thinking skills with moderate effectiveness	- uses thinking skills with considerable effectiveness	- uses thinking skills with a high degree of effectiveness
Communication TFS.07X SPV.03X SPS.04X SPS.03X	- communicates information with limited clarity	- communicates information with moderate clarity	- communicates information with considerable clarity	- communicates information with a high degree of clarity, and with confidence
Application ICV.01X ICS.01X SPS.01X SPS.08X	- 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

Accommodations

Teachers may adapt this activity to match student research into signal devices, structures, mechanisms, and electronics. Students with advanced knowledge or skills may be paired with students who would benefit from assistance. Teachers may provide more guidance for specific students or simply direct these students to follow the circuit construction process in a very prescriptive manner. Including additional problem solving exercises easily enhances all stages of this activity. This project allows for a wide variety of skill or knowledge levels. Teachers ensure students with special needs have productive roles to play within all stages of the signal device design and construction.

Resources

Books
Tokheim, Roger. *Digital Electronics*. ISBN: 0-07-064980-4

Software
Electronic Workbench. Ministry of Education and Training School Licensed software.

Activity 4: Millennium Time Capsule

Time: 400 minutes

Description

Students create a time capsule to preserve thoughts, ideas, and icons of their life for future examination. Students garner a sense of history and ownership by examining their present lives at home, school, and in their community. Students select artifacts, determine and use methods and materials of historical preservation, and develop the project using principles of engineering project management. Students then construct a container to save and preserve their artifacts for a predetermined time. This activity integrates material science, design, construction, communications, business, and the arts.

Strand(s) and Expectations

Strand(s): Theory and Foundations, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.02X, TFV.03X, SPV.01X, SPV.02X, SPV.03X, SPV.04X, SPV.05X, ICV.01X, ICV.02X, ICV.05X.
Specific Expectations: TFS.0lX, TFS.02X, TFS.03X, TFS.04X, TFS.05X, SPS.01X, SPS.02X, SPS.03X, SPS.04X, SPS.05X, SPS.07X, SPS.08X, ICS.01X, ICS.02X, ICS.03X, ICS.04X, ICS.07X.

Planning Notes

This activity provides students an opportunity to characterize their life at the beginning of their high school years, gives them a sense of history and ownership, and provides them with a sense of progression. Students also gain the opportunity to work with parents, teachers, and their local community. The completed activity may form the basis of a school-wide or community-based project, depending on local resources and time limitations. Initial time capsules may be designed for opening in four years, during the capsule builders' year of graduation. This project, however, may also be modified to last any number of years. In addition, items can be added to the time capsule upon graduation, with the intent of re-opening the capsule at a later date. The central focus of the project is the design and construction of a container for chosen artifacts. Teachers review and demonstrate the safe use of hand and power tools before allowing students to use equipment. Suggested materials for capsule construction include plastics, wood, metals, or, more importantly, recycled materials. Suggested artifacts include selected writings, images, photographs, recorded CDs, diskettes or other computer storage media, current popular toys, videos, or games, future predictions, newspaper or magazine clippings, science samples (seeds, DNA, etc.), or paraphernalia from parents, staff, other classes, and the community.

Students research the expected life of materials and information storage media. Local libraries and museums are valuable resources in this regard. Teachers encourage students to reflect whether CDs, diskettes, tapes, computer games, etc. will be readable by devices in the future. Students are made aware of the design process, including identifying needs and criteria, researching current situations, proposing and analysing possible solutions, developing models, testing solutions against established criteria, and preparing analysis for further developments. Consideration is given to ensure every student contributes something personal to the time capsule. Teachers' sensitivity to all students' needs and interests when determining

time capsule artifacts ensures representation by both gender groups and a balanced representation of ethnocultural groups in the local community. Teachers encourage students to highlight Canadian and local values and culture in the production of their project.

Prior Knowledge Required

Participants have a working knowledge of computer operations such as word processing, creating graphics, printing documents, and managing files. As well, participants have some knowledge of Internet research and are familiar with computer usage regulations as defined at the local level. Participants also have some knowledge of measurement techniques and calculations, and elementary drafting/dimensioning conventions. Students with expertise in computer operations may be paired with classmates who have less knowledge in this area. Teachers do not assume that students have prior knowledge of safety issues involving materials processing and assembly and, therefore, emphasize proper safety precautions and demonstrate proper usage of equipment and materials before allowing students to begin the project.

Curriculum expectations outlined in *the Ontario Curriculum Grades 1-8 Science and Technology* document are reinforced through the design and construction of the time capsule. Particular examples can be adapted from:

- Structures and Mechanisms: Grade 5: Forces Acting on Structures and Mechanisms;
- Structures and Mechanisms Grade 7: Structural Strength and Stability;

Topics chosen from other curricula may also be addressed, highlighting the importance of integrating technology into the learning process.

Teaching/Learning Strategies

The capsule building activity promotes a variety of experiential learning strategies, including participating in hands-on construction, processing materials, problem solving, following design procedures (see Appendix 1), communicating ideas through graphic design, presenting completed work, writing technical reports, and facilitating group design activities. Individual work includes sketching, writing and researching, constructing individual capsule components and preparing artifacts. Group activities include brainstorming, deciding about design, organizing duties, and assembling the final product. Students present the final product within the classroom, or with other classrooms or community groups.

Activity Instructions

1. Students receive a prepared project description (design brief) outlining time capsule requirements. Students brainstorm about what kinds of artifacts would be desirable to preserve in the predetermined storage time (potentially four years, when current students are expected to graduate).
2. Students develop a name and logo identity for a company that organizes the project. Students then work in groups and compose a survey to request artifact ideas from family, staff, homerooms, and/or community groups and businesses.
3. Students are organized in project teams with specific responsibilities, such as capsule design, materials research, database compilation, artifact selection/preparation, and project management. Each team elects a project manager to work directly with other project managers in making decisions and establishing time lines. At this time, the class also discusses the proposed size of the time capsule.
4. Students analyse the requirements of their particular roles, brainstorm ideas and directions, produce sketches, scale models, or database designs (where appropriate), and write proposals for teacher approval. Students sell or "pitch" their ideas to the class in a critiquing session.
5. Students research previous time capsule designs, sources of long lasting materials such as acid-free paper, and preservation methods for the variety of artifact materials.
6. Capsule design team members investigate materials, sketch and/or draft dimensioned drawings for fabrication, and construct the capsule and associated components. Possible construction materials

include plastics, wood, stainless steel, aluminum, or fiberglass. Students examine recycled materials or found objects. Students design methods of sealing the capsule to ensure longevity of container and artifact materials.

7. Artifact selection and preparation team members collect, catalogue, and prepare artifacts. Survey team members compile documentation while project managers ensure deadlines are met.
8. A celebration event is held to seal the contents in the capsule and to locate the capsule in a safe, out-of-the-way place. Potential locations include the tops of classroom bookshelves, mechanical rooms in the school, display cases, or locations on school grounds where the capsule can be buried.

Assessment/Evaluation

	Level 1	**Level 2**	**Level 3**	**Level 4**
Understanding of concepts TFV.01X TFS.05X SPS.02X ICS.07X	- demonstrates limited understanding of artifact preservation requirements	- demonstrates some understanding of artifact preservation requirements	- demonstrates considerable understanding of artifact preservation requirements	- demonstrates thorough and insightful understanding of artifact preservation requirements
Thinking/Inquiry TFS.01X TFS.04X	- uses thinking skills to identify and solve problems with limited effectiveness	- uses thinking skills to identify and solve problems with moderate effectiveness	- uses thinking skills to identify and solve problems with considerable effectiveness	- uses thinking skills to identify and solve problems with high degree of effectiveness
Application of inquiry/design TFS.02X TFS.04X SPV.05X SPS.01X SPS.05X	- applies few strategies such as sketching, dimension calculation, or project planning - demonstrates limited research skills	- applies some strategies such as sketching, dimension calculation, or project planning - demonstrates some research skills	- applies a variety of strategies such as sketching, dimension calculation, or project planning - demonstrates effective research skills	- applies many effective strategies such as sketching, dimension calculation, or project planning - demonstrates comprehensive and insightful research skills
Communication of Information TFV.02X TFS.03X SPV.02X SPS.03X SPS.04X	- communicates design ideas and project reports with limited clarity	- communicates design ideas and project reports with moderate clarity	- communicates design ideas and project reports with considerable clarity	- communicates design ideas and project reports with a high degree of clarity

	Level 1	Level 2	Level 3	Level 4
Application of equipment, procedures, and technology TFV.01X SPV.01X SPV.03X SPV.04X SPS.07X SPS.08X ICV.01X ICV.02X ICV.05X ICS.01X ICS.02X ICS.03X ICS.04X	- 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

Accommodations

This activity can be adapted by varying the amount of research required, degree of difficulty in project work, and longevity requirements of the final product. Teachers may opt to provide more guidance for individuals or allocate simpler designs. Individual students may be paired with students having more advanced knowledge or skills. By incorporating a wide variety of skill or knowledge levels, this project enables students with special needs to assume productive roles and responsibilities. Enrichment activity/extension work may involve working with a larger community, designing a multiplicity of capsules for varying numbers of years, designing a vandal-proof marker, and burying the capsule on school grounds. Advanced students may access leadership opportunities through project manager functions.

Resources

Libraries and museums maintain information about artifact preservation techniques. School librarians are valuable resource persons for this type of research.

Books

Caney, Steven. *Make Your Own Time Capsule*. Workman Publishing, 1992. ISBN 0894804189

Packard, Mary and Brian Floca. *Make Your Own Time Capsule*. Troll Assoc., 1999. ISBN 0816749760

Web Sites

The following commercial sites represent a few of the many Internet resources available (also, try searching under "time capsule" in any search engine or portal):

Millennium Time Capsule
http://www.time-capsule.com

Future Archaeology
http://www.futurearchaeology.com

Time Capsules and Future Packaging
http://www.mindspring.com/~futurepkg/index.htm

Unit 4: Computer Science and Technology

Time: 22 hours

Unit Developer(s)

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Stan Galda
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Simcoe County District School Board: Lead Board

Development Date: July 1999

Unit Description

Students use computers and a computer programming language to complete a multitude of tasks. Through a variety of projects, students develop a needs assessment survey for a service-based industry, create an image of a static scene (lakeside, garden, or other natural setting), send digital messages over a specified distance, and create a 3-dimensional virtual reality object using Virtual Reality Modelling Language.

Strand(s) and Expectations

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

Overall Expectations: TFV.01X, TFV.02X, TFV.03X, TFV.04X, TFV.05X, SPV.01X, SPV.03X, SPV.02X, SPV.03X, SPV.05X, ICV.01X, ICV.03X, ICV.04X, ICV.05X.

Specific Expectations: TFS.01X, TFS.02X, TFS.03X, TFS.04X, TFS.06X, SPS.01X, SPS.02X, SPS.03X, SPS.04X, SPS.05X, SPS.07X, SPS.08X, SPS.09X, ICS.01X, ICS.02X, ICS.05X, ICS.06X, ICS.07X.

Activity Titles (Time + Sequence)

Activity 1	Programming A Lakeside Scene	300 minutes
Activity 2	Design a Technical Facility	320 minutes
Activity 3	Design A Computer	300 minutes
Activity 4	Programming Using Virtual Reality Modelling Language	400 minutes

Unit Planning Notes

Ensure all necessary references, equipment, and resources listed in each activity are available for students' use. Materials for review, activities, and research may be obtained from a variety of sources including web site addresses, and school and community libraries. Teachers should become familiar with computer hardware and software available to the students. As well, students and teachers benefit from contacting local businesses in the computer sector. These community members may also provide students with insights into career opportunities and education requirements, as well as potentially offer students co-operative education learning opportunities in Grades 11 or 12. Teachers should perform the activity before implementation to familiarize themselves with all necessary safety considerations and to ensure that all facility, equipment, and material requirements are available.

Prior Knowledge Required

Students must demonstrate an understanding of: the operation of a service-based business, technology used in the industry, factors contributing to the efficient operation of systems, word-processing skills, how to evaluate their own design in terms of meeting criteria, the fundamentals of computer operation, how to log onto a networking system, and safe and acceptable use policies with respect to computer hardware and Internet use. They must know how to use computers as a tool to find information and produce documentation.

Students have received an introduction to the design and construction of series parallel electrical circuits. Participants are aware of basic safety precautions and correct usage of power and hand tools.

Teaching/Learning Strategies

This unit incorporates a variety of teaching and learning strategies, including teacher-directed activities, individual learning activities, group work, and co-operative learning strategies. Teachers provide students with the information, resources, and guidance necessary to complete each task safely and with maximum opportunity for success. Students are provided with opportunities to work independently and in groups to perform the following tasks: problem solving, brainstorming, following various design procedures, collecting information, writing reports, assessing and evaluating projects, and making classroom presentations. Activities are modified to meet the needs of all learners by applying accommodations such as: allowing increased time for activities, enhancing or compacting content, assisting during the evaluation processes, and facilitating peer-tutor assistance where possible. Teachers must supervise students' safe operation of only those hand and power tools that the teachers themselves are skilled at using safely. If a teacher is uncertain about the correct use of equipment, then an alternate activity should be selected for students.

Assessment/Evaluation

Methods of assessment and evaluation must include a wide variety of approaches to enhance student learning. Assessment methods may include: student-designed assessment criteria, performance assessments such as projects and skill demonstrations, personal communication, assessment processes such as instructional questions and answers, conferences, classroom discussions, journals or log books, and standardized tests such as classroom tests or examinations. Each activity contains a sample rubric for assessment, which may be used by the teacher and/or student.

Resources

Resources required for this unit include: the Corel Suite 8 manual, *An Introduction to Visual Basic 5 and 6* or *The Turing Tutorial Guide* is of value for programming reference and interesting projects, *The Don't Panic Guide to Programming*, Holt Software c. 1999, *Choices 99* or *Career Cruising*, and informational resources for VRML code samples and tutorials.

Small electronic hand tools, prototype circuit boards, electricity sources (batteries or low-voltage power supplies), 26-gauge wire (e.g., surplus telephone wire), small low-voltage lamps (or light emitting diodes - LED's).

A computer training kit *The Journey Inside*, available from Intel Corporation, contains two videos, an instructional binder, and electronic components.

Activity 1: Programming A Lakeside Scene

Time: 300 minutes

Description

Students create a computer-generated image of a static lakeside, garden, or other natural setting. Specific elemental graphical units are applied in a step-by-step fashion. Animation is also included in this image-making process. Students demonstrate knowledge of fundamental programming, graphics structures, planning practices, design processes, communication, and related computer-programming skills.

Strand(s) and Expectations

Strand(s): Theory and Foundations, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.05X, SPV.03X, SPV.05X.
Specific Expectations: TFS.02X, TFS.06X, TFS.03X, TFS.04X, SPS.01X, SPS.04X, SPS.09X, ICS.06X.

Planning Notes

Careful preparation is required to complete a programming project. Teachers introduce a problem-solving model to prepare students for their task of approaching and developing a solution logically and successfully. This project requires the use of a programming language such as Visual Basic or Turing that supports graphical structures. These programs operate suitably on a Pentium workstation in the range of a P266 or higher. Several graphics related projects in the Teacher Resource Book produced by Turing publisher Holt Software provide excellent starting points for this project. Initial planning stages of the problem-solving model require flowcharting and word-processing software such as *Corel Wordperfect Suite* or *Microsoft Office*.

Prior Knowledge Required

Students have mastered the fundamentals of computer operation, including opening, saving, managing, and printing files on a computer system. Some students know how to log onto a networked system and are aware of the safe and acceptable use policies with respect to computer hardware and Internet use. In addition, they should have experience in communicating design specifics to an appropriate audience using various tools including word processors, handwritten descriptions, drawings, and oral presentations.

Teaching/Learning Strategies

Teachers "walk" students through a sample graphical activity to introduce the problem-solving model and its application. This walk through formally introduces the various language statements available in the selected programming language, including drawing lines, circles, rectangles, and points, filling objects, and creating animation. This introduction may be adapted to accommodate learners with varying levels of computer programming skills and experience. For example, teachers may show sample projects to students who need more detailed help as they design their own projects. This accommodation ensures all students' project proposals are feasible for the time allowed. Teachers apply a step-by-step problem-solving model. A teacher-directed delivery model allows students to work with the teacher to create a common lakeshore (water, beach, grass, one tree, etc.), and ensures all students can initiate the project successfully and work through all stages of the process, including debugging. To enhance the learning opportunity, teachers allow students to continue by individualizing the scene.

Planning

1. Students type a description and sketch the scene and its various components.
2. Students develop a top-down flowchart to illustrate the order in which components are implemented.

Implementation

3. Students prepare pseudo-code instructions of the scene.
4. Students translate the flowchart into actual instructions and coding into computer.
5. Students debug the program.

Evaluation/Presentation

6. Students verify the product satisfies the original specifications.
7. Students suggest enhancements/improvements.
8. Students compare a programmed solution to one using an alternate software tool.
9. Students present the final product.

Teachers outline the planning steps with the sample scene. Students carry out the planning steps with their chosen design. Teachers carefully explain the operation of various drawing commands, the use of loops, variables, and decision structures, and the co-ordinate system and how it works - particularly for students who require concrete logical instructions. Teachers exercise caution in teaching about syntax/logic errors and debugging programs in addition to the other programming structures. Teachers should avoid an exhaustive treatment of programming theory at the Grade 9 level. Instead, students are allowed to assimilate the theory from an intuitive perspective. Teachers may take a natural and logical approach by implementing the flowchart modules as individual procedures within the program. Students may work in pairs, depending on time constraints and levels of sophistication in student projects. This approach is very effective for accommodating differing levels of ability among students. A class discussion helps students explore other software tools such as *CorelDRAW™ or Animator Pro* as more effective vehicles for completing this project. Hopefully, students use one of the alternate tools to solve the same problem and analyse the benefits of both approaches.

Activity Instructions

Using a word processor, students write a proposal describing how the graphics scene should look and work. The proposal includes a discussion of careers relating to this area of computer studies and examples researched from the Internet. Related careers include commercial design and film production, among others. Students create a top-down flowchart of the project. This planning step allows for a logical analysis of each component. Pseudo-code is required at this point. Students write instructional statements such as "draw a line from (0,0) to (24,56) in red" or "fill in blue the area below line #5". This activity helps students appreciate that a large project is synthesized from smaller individual instructions/units. The pseudo-code from Planning step 3 above is translated into real computer instructions in the chosen language. Students create a module of code and then follow by debugging this code. They run the module and correct errors in syntax and logic until the module operates satisfactorily.

Students evaluate the product when the program is completed. Students prepare a written report outlining the extent that the project adhered to the original design and why any changes made were necessary. This report includes an analysis of how the project can be improved or enhanced, and a potential target audience if it were to be distributed or marketed. Presentation is a natural next step after creating a piece of artwork. Students are given the opportunity to print the work on a colour printer for pasteboard display and/or use a presentation tool such as Corel Presentations or Microsoft Power Point to create a slide show of all the projects in the class.

Assessment/Evaluation

In order for the teacher to determine at what level each student is in regard to computer programming, it is suggested that a pre-assessment test be given to all students to ensure they progress and achieve. Evaluation is an on-going process. In addition to class performance each stage of product development may be evaluated individually. Teachers may award a percentage of the final mark to the written proposal prepared on a word processor and correctly formatted, the flowchart created either with pencil and ruler or a desktop publishing program, the pseudo code created on a word processor, and the program. Peer- and self-assessment during presentations allow students to view all products and compare them in terms of quality and levels of difficulty. In addition, each student evaluates their own project based upon criteria set by teachers and/or class consensus. Teachers grade the written proposals and monitor the proposals' appropriate level of difficulty for each student. This approach enables students of differing ability to attempt projects within their grasp.

Understanding all stages of the problem-solving model, plus being able to apply the basic programming statements, might be included in a test, provided that some portion of the test involves actual computer programming on the computer.

	Level 1	**Level 2**	**Level 3**	**Level 4**
Knowledge and understanding TFV.05X TFS.02X TFS.03X TFS.06X	- demonstrates limited knowledge of concepts and terminology	- demonstrates some knowledge of concepts and terminology	- demonstrates considerable knowledge of concepts and terminology	- demonstrates thorough knowledge of concepts and terminology
Communication SPV.05X	- 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 SPV.03X SPS.01X SPS.09X SPS.04X	- uses procedures correctly only with supervision	- uses procedures correctly with some supervision	- uses procedures correctly	- demonstrates and promotes the correct use of procedures
Communication ICS.06X TFS.04X	- communicates information with limited clarity	- communicates information with moderate clarity	- communicates information with considerable clarity	- communicates information with a high degree of clarity and confidence

Accommodations

Teachers help students who experience difficulty creating the program by providing them with several ready-made projects, complete with all planning documentation and program code. In addition, a pre-formatted word processor template may be appropriate for individuals who have difficulty adhering to a particular formatting style. For students who show an interest in this area or require greater challenges, teachers should be prepared with a list of project extensions or sample problems that require non-graphical applications of computer programming.

Resources

The Corel Suite 8 manual or resource book is useful for teachers and students. The language reference, for example, *An Introduction to Visual Basic 5 and 6* or *The Turing Tutorial Guide* is of value for programming reference and interesting projects. As mentioned earlier, the Holt Software "Teacher's Resource Book" is invaluable when introducing programming through graphics. *Choices 99* and *Career Cruising* are most useful when searching for careers and educational paths in the computer graphics area.

Activity 2: Design a Technical Facility

Time: 320 minutes

Description

Students design a technical facility through the application of the design process. They then develop a computer program using a computer programming language that compares the cost of various materials used in their design. The activity may be expanded to include the building of a model to display their design.

Strand(s) and Expectations

Strand(s): Theory and Foundations, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.03X, TFV.05X, SPV.01X, SPV.05X.
Specific Expectations: TFS.01X, TFS.04X, TFS.06X, SPS.01X, SPS.09X.

Planning Notes

Preparation for the design of the technical facility includes research into local technical businesses and the costing of various products. This activity requires at least one computer for every pair of students. A programming language and a word processing program must be available on the computers.

Prior Knowledge Required

For this activity, students benefit from having some familiarity with local businesses. A tour of the school technology department may be an alternative. Students should be able to demonstrate an understanding of the factors that contribute to an inviting working environment and to an efficient service provider. Students evaluate their own designs in terms of addressing the need of the client and the modifications required to improve the end result. Students use a word-processing program and perform area calculations. An ability to generate a plan view drawing of a room assists the students in performing this activity.

Teaching/Learning Strategies

Student must first engage in a group activity (The Perfect Mime), which emphasizes the importance of accuracy in computer programming. Working with computers, the teacher next assigns programming language tasks of progressively increasing complexity. Activities may be modified to suit varying learning needs (see Accommodations). Finally, in pairs, students design a technical facility and do the interior design, then create a program that generates a comparison of the cost of using various products and different technical facility sizes. An alternative would be to cost out the building materials required for a product, using various materials.

Part I: The Perfect Mime - An Introduction to Structured Programming

The teacher displays to the class a list of instructions to accomplish the task of frying an egg. The teacher then reads the list to the class, having one student mime the motions as the reading takes place. The student is instructed to do nothing more than exactly what is said. The teacher may wish to set up the student beforehand to purposely misinterpret an instruction.

In small groups, students choose a task to be described by their group and generate a list of task instructions. Suggested tasks for description include baking a cake, changing a flat tire, riding a bicycle, walking to school, cleaning one's teeth, tying a shoe lace, building a tree fort, etc.

When finished, students present their lists to the class. For each presentation, the teacher selects a second group to act as "critical mimes". Each group should have an opportunity to critique. The critical mimes record the number of times they could do a required action incorrectly by following instructions provided by the presenting group. This value is used later to evaluate this activity. Students may return to their workstations to correct or improve their instruction descriptions based on the actions of the critical mimes.

To conclude the activity, the teacher explains that accuracy is important when programming because:

- computers do exactly what one says;
- computers do not make assumptions;
- computers do not work if instructions are not given perfectly.

The computer is, in effect, the "perfect mime".

Part II: Creating a Simple Linear Program

The teacher provides an introduction to the programming language of his or her choice. Working in pairs, students are provided with an example of the "Hello World" program (see Resources) and are encouraged to expand the concept of generating computer output to display various types of information.

To further develop understanding, students are asked to create programs that greet them with their own names. Students then change seats. The teacher uses the fact that all of the computers now greet their users incorrectly as an introduction to input and variables. The teacher may generate a sample program that requests the user's name, stores it in a variable, and then uses the variable content to greet the user with the entered name.

The introductory lesson on input/output includes exploratory learning and creative expression from the students. Students generate simple computer programs using the assigned computer language. For example, students can be asked to design a program that asks questions about their favourite sport or music, and another that can make simple calculations for payslips that uses constants. The final lessons should include graphics for selection and output.

Students learn the importance of formatting the output and assessing the ease of comprehension. Graphics on the input screens and in the paper output are required.

Part III: Designing the Technical Facility

Students work in pairs. Each team decides on the type of technology service facility they will design (e.g., hair salon, motorcycle repair facility, computer repair facility, marina technical facility, ceramics facility, auto mechanics facility, a textiles facility). This design does not include any special tools or fixtures. Students think about the needs of the customer and the business owner. Environmental issues arising from the use of various building materials are discussed in class to help students select materials that are least harmful to the environment. Students draft the outline of their technical facility with approximate dimensions included.

Student groups then research (using the school library/resource centre, various catalogues, and local advertising flyers) the types of products they could use to finish the interior of their design. They use this information for the input portion of their program. They should choose at least three different products for the walls, floors, and ceilings. Students use the Internet and school library/resource centre to research floor, wall, and ceiling fabrication choices and costs.

The teacher and students establish what information is required to complete the programming task (e.g., dimensions, costs, items, etc.). In consultation with the teacher, groups choose an appropriate format to display their results. Each team then presents their project proposal to the class.

After all proposals have been presented, teams have the opportunity to include desirable features from other groups' plans and remove unwanted items from their own plans.

Part IV: Creating the Costing Program

Students create a program that generates the comparable costs of their design. The completed program interacts with the user, allowing for input of all relevant information, and should allow the results to be printed out on a local printer. The printed copy is used by the team to determine which combination of products is the most expensive, and which is the least expensive. Teachers may have the dimensions of the classroom available with appropriate area calculations so students may check the calculation portion of their program.

Part V: Integration Extensions

Students take the information they have learned and build a model of the least or most costly design. The model includes colour chips, samples of flooring, and wall coverings.

Students alter this program to cost out any project they wish to complete in a technology setting or in their personal life.

Depending on the comfort level of students, they may include loops and decision structures to create a more sophisticated program.

Assessment/Evaluation

	Level One	Level Two	Level Three	Level Four
Understanding of Concepts TFV.01X TFV.05X TFS.06X	- demonstrates limited understanding of computer concepts	- demonstrates some understanding of computer concepts	- demonstrates considerable understanding of computer concepts	- demonstrates thorough and insightful understanding of computer concepts
Thinking Skills TFS.01X TFS.04X SPS.01X	- solves design problems with limited effectiveness	- solves design problems with moderate effectiveness	- solves design problems with considerable effectiveness	- solves design problems with a high degree of effectiveness
Use of language and symbols SPS.09X	- communicates information with limited clarity	- communicates information with moderate clarity	- communicates information with considerable clarity	- communicates information with a high degree of clarity and confidence
Making connections ICV.03X ICS.06X	- makes connections relating services to the needs of the community with limited effectiveness	- makes connections relating services to the needs of the community with moderate effectiveness	- makes connections relating services to the needs of the community with considerable effectiveness	- makes connections relating services to the needs of the community with a high degree of effectiveness

Pre-assessment testing is suggested to assist the teacher in establishing students' computer knowledge prior to commencing the activity. During critiquing stage (Part 1: The Perfect Mime), the teacher may assess students' understanding of project criteria and ability to suggest improvements.
Through observation, the teacher assesses the students' appropriate use of computers (following school guidelines) and their ability to save their work successfully. Teachers provide the students with a checklist of the necessary criteria in their design report to ensure that all aspects of the design report are addressed. The design of the technical facility is presented in a format that has been established prior to the onset of the project. The teacher must assess the design work as it is ongoing to ensure that the student is meeting all of the requirements of this component. Self- and peer-assessment takes place at the end of the activity, when student groups are presenting their final product. As a class, a marking scheme is developed prior to the presentations, to reflect all aspects of the presentation.

Accommodations

Students with special needs may use a visual language to create their cost comparison program. The visual group of languages utilizes easy access to incorporate large fonts for visually-challenged students, as well as sound files and voice recognition to assist with reading and typing handicaps. Varying the type of facility design tasks or the mime topic can accommodate learners with varying skill levels and prior knowledge.

Resources

Software

Turing Version 8.0a; Holt Software C. 1998, Cdn.; *Qbasic* - Freeware provided with Microsoft Operating Systems; *Quick Basic Version 4.5*, Microsoft Corporation C. 1985, *Borland Turbo Pascal*, Borland Inc. C. 1992. *The Don't Panic Guide to Programming*, Holt Software c. 1999, Cdn

Websites:

Online tutorial of QBASIC/QUICKBASIC 4.5
http://www.alphalink.com.au/~alain/qbas/

A Pascal page linking you to many excellent references
http://www.borland.com/pascal/turpas15.html

How to purchase Pascal
http://www.borland.com/ecommerce/

Turing examples and purchase information
http://www.holtsoft.com/

The "Hello World" example can be found at
http://www.alphalink.com.au/~alain/qbas/

Activity 3: Design a Computer

Time: 300 minutes

Description

Working in groups of three or four, students design a computer. Using information from the Internet, students research the required components and their specifications, create a database of components, calculate the total cost using a spreadsheet and, if possible, build their system (see Teaching/Learning Strategies for options). The project also includes the development of a manual that describes their computer system, including terms, intended use, components, and cost.

Strand(s) and Expectations

Strand(s): Theory and Foundations, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.02X, SPV.01X, SPV.03X, SPV.04X, ICV.05X.
Specific Expectations: TFS.03X, TFS.04X, SPS.01X, SPS.04X, SPS.05X. SPS.06X, ICS.02X.

Planning Notes

- This activity requires at least one computer for every two students complete with Internet access, a word-processing program, a spreadsheet program, a database program, and access to a printer. The word processor is used to help students create their manual.
- Required materials include the computer training kit *The Journey Inside* (see Resources). Although this kit contains some of the components necessary, more are required for the class. An old computer to disassemble at the beginning of the project assists in recognition of the component technology. It would also be beneficial to have printed resources available, such as computer books and magazines.
- The teacher should periodically check the Internet sites being used by the students to ensure they are still available and contain the required information.

- Invite a local computer supplier/technician to demonstrate the assembly of a system or to help make one for the classroom. This will enable students to complete the task of building a complete operational computer system.

Prior Knowledge Required

Students should have experience working in groups as well as in using the computer for conducting research on the Internet. Students are to create word-processed documents and be familiar with the school's Acceptable Use Computer Policy and the expectations regarding the use of hand tools in a technical facility. The students are to keep organized notebooks detailing their increased knowledge.

Teaching/Learning Strategies

The video, *The Journey Inside*, helps students understand concepts and reinforce lab discussions and activities. Student notebooks must include a glossary of terms, which are developed throughout this activity. Encourage students to use this terminology fluently.

Introduction to the design process includes a discussion on how to identify the computing needs of a potential client and how to generate appropriate solutions to their needs. Students are then presented with a problem and asked to find the best design for their system that meets client needs.

The use of the Internet as a research tool requires an explanation of searching techniques, web address protocol, and how to evaluate various types of sites. Students use a variety of available software to create a database of their system components research, spreadsheets to calculate costs, and word processing to write the computer manual. In this activity the teacher reviews safety concerns regarding use of the computer for extended periods of time. Advise students to sit up straight at the keyboard, not sit too close to the monitor, and take the occasional break to stand and stretch.

Students have an opportunity to handle and install various computer components either individually or in groups. The system assembly portion of this activity varies significantly depending on available funding, resources, and technical expertise. Students may simply reassemble an older computer system or participate in the design and assembly of an up-to-date system. Demonstrated knowledge of a respect for the working environment as well as computer-related tools and components would be essential.

Activity Instructions

The teacher introduces the activity by asking students to identify the components in a system such as a bicycle or the nervous system. The students and teacher then discuss how the components in a system must interact for the system to work. This discussion should then be compared to a functional computer.

Students view the video *The Journey Inside* which gives a foundation of the concepts to be researched by the students. Students note the concepts of input, memory (two types), information processing, and output. Teachers may introduce various items from the kit to the students to complement the introductory lesson.

Students can begin a glossary of computer terms by researching on the Internet the meanings of key components for a computer system such as: monitor, scanner, printer, keyboard, mouse, motherboard, video card, sound card, central processor, random access memory (RAM), power supply, etc. (See Resources for appropriate web site address.) This would be an ideal opportunity to discuss the challenges with research on the Internet. Students review how to enter search terms, understand web address protocol, and how to evaluate sites once they have accessed them. Print resources such as computer magazines may be used to supplement the Internet research activity.

The procedure for disassembling an old computer (without damaging the parts) is demonstrated by the teacher to assist students in the physical identification of components and provide an opportunity to reinforce key safety considerations.

Safety issues to review include:

- ensure that all power cords are removed;
- never attempt to open a monitor due to the danger associated with some internal components;
- the safe use of basic hand tools.

If additional old systems are available, students may work in small groups to disassemble their own machines. Handling the components enhances the students' understanding of the challenge and provides the background knowledge to begin the challenge.

Design a Computer System

The teacher presents the students with the problem of designing a computer that meets the needs of the average high school student. The students' solution to the design challenge must include a reference manual document that describes the system components, performance characteristics, and costs. Depending on the availability of older systems, school resources, and community support, the actual finished computer system students' produce will vary significantly.

A class discussion should be held to describe what an acceptable computer system and manual would look like, and what skills the students require to complete this task successfully. Working in groups, students then discuss the needs of the user and begin a plan for the design of their computer. It must be noted that the original plan may change as students learn more about computer components. At this point students share their thoughts and ideas for their group's system. This strategy assists students in clarifying their thinking and allows them to use other students as a resource.

Each group is asked to assign individuals to specific tasks (i.e. research, data entry, spreadsheet calculation and word processing). Students are rotated through each role to allow them the opportunity to experience each task. By the end of the exercise each student should have researched computer design considerations and the components necessary for their system, compiled the information in a database, calculated the projected costs, and entered information into their computer manual. The teacher may create a database and spreadsheet template that students can retrieve from a central directory to track their role at any time in the activity.

In the role of researcher, encourage students to use current print resources available in the library/resource centre and computer lab. Students should be encouraged to communicate relevant information to the appropriate member of their team so that all members can complete their assigned tasks. Entries are made and files stored in a directory for their team. While on-line, encourage students to use the on-line dictionary to help them with any terms that are unfamiliar to them. Students may be given specific time limits in each role.

Upon completion of the group's research into the characteristics of their computer system, each group compiles their findings and presents their design and manual to the rest of the class. They also have an opportunity to evaluate the designs and manuals presented by other groups.

Depending on resources available, the culminating practical exercise may have the students:

- disassemble and reassemble an older system and reconfigure it to working order;
- diagnose and repair an old system;
- create a computer with available parts (discuss compatibility);
- upgrade an older system to enhance its performance;
- assemble and configure a new system if the resources and technical support is available.

Throughout this activity, it is important to encourage students to use all computer terminology correctly.

Assessment/Evaluation

	Level One	Level Two	Level Three	Level Four
Understanding of Concepts TFV.01X SPS.O5X ICS.O2X	-demonstrates limited understanding of computer component concepts	-demonstrates some understanding of computer component concepts	-demonstrates considerable understanding of computer component concepts	-demonstrates thorough and insightful understanding of computer component concepts
Thinking Skills SPV.03X SPV.04X SPS.01X	-solves design problems with limited effectiveness	-solves design problems with moderate effectiveness	-solves design problems with considerable effectiveness	-solves design problems with a high degree of effectiveness
Communication TFV.02X TFS.03X	-communicates information with limited clarity	-communicates information with moderate clarity	-communicates information with considerable clarity	-communicates information with a high degree of clarity and with confidence
Making Connections SPV.01X SPS.06X	-makes connections relating services to the needs of the community with limited effectiveness	-makes connections relating services to the needs of the community with moderate effectiveness	-makes connections relating services to the needs of the community with considerable effectiveness	-makes connections relating services to the needs of the community with a high degree of effectiveness

To have students review their learning, the teacher may incorporate a number of paper and pencil tests. Teachers conference with groups as the project develops to assist the students in any areas they are experiencing difficulty. Peer-assessment of student-developed computer manuals allows students to view all products and compare them in terms of quality of information and presentation. The final project is assessed by their peers using a rubric either created by the teacher or created by the students at the beginning of the project. The teacher evaluates the computer manual. Tracking sheets for each team member are used as a time management tool. These are submitted to the teacher with the computer manual but not assessed.

Accommodations

Students with special needs may use materials that have been enlarged (e.g., computer screen magnifier). The use of magnifiers in the classroom for the components would also be helpful. Students with minimal prior experience with computers may be paired with someone who has more experience. Teachers may create ready-made templates for students' use during the database and spreadsheet portion. The activity may be extended to challenge students by having them view the complete video *The Journey Inside*. It contains several modules that explain how data is processed and also the impact of technology on industry. Other enrichment opportunities may include asking some students to add peripherals and the corresponding components to their systems. The amount of time allowed for each stage of the activity could be altered to allow for the needs of individual students.

Resources

White, Ron. *How Computers Work*. Quebec, Canada, 1997. ISBN 01-56-276546-9

Norton, Peter. *Essential Concepts*. McGraw-Hill Ryerson Limited, 1999. ISBN 0-02-804394-4

Websites

Dictionary
http://www.webopedia.com

Design and Research
http://www.aug.edu/~sbastk/Upgrading.htm

Product Information &#9
http://www.intel.com/intel/product/index.htm
http://www.paragon-tech.com/

Quality on the Internet Tutorial
http://www.netskills.ac.uk/TonicNG/cgi/sesame?tng

Video Kit

Intel Corporation. *The Journey Inside*. 1996. (Video, Instructional Binder, Electronic Components)

Activity 4: Programming using Virtual Reality Modelling Language

Time: 400 minutes

Description

Students demonstrate knowledge of computer-programming concepts by creating 3-dimensional virtual reality objects using Virtual Reality Modelling Language (VRML). Students employ the principles of design, computer programming, and co-ordinate geometry to model simple objects in 3-D for viewing on local computers or through the Internet. VRML is a no-cost, text-based language that can be used to model everything from simple geometry to complex animations. This activity integrates computer programming, communications, design, mathematics, and science.

Strand(s) and Expectations

Strand(s): Theory and Foundations, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.02X, TFV.04X, TFV.05X, SPV.01X, SPV.02X, SPV.03X, SPV.05X, ICV.03X, ICV.04X, ICV.05X.
Specific Expectations: TFS.0lX, TFS.02X, TFS.03X, TFS.04X, TFS.06X, SPS.01X, SPS.02X, SPS.03X, SPS.04X, SPS.05X, SPS.07X, SPS.09X, ICS.02X, ICS.05X, ICS.06X, ICS.07X.

Planning Notes

Virtual Reality Modelling Language (VRML) is a free ASCII text-based language for describing 3-D objects and scenes called 'worlds'. Like HTML (Hypertext Markup Language), it can be produced with simple, free editors; is viewed with a free browser; and can be posted on the Internet. While capable of dealing with complex geometry, interactively, while scripting, VRML coding can also be accomplished by using simple primitives such as spheres, cylinders, boxes, and cones. All manners of objects can be built using primitives. For example, a cylinder can be made to represent everything from a flat plate to a flagpole. Specific programs are required to interpret codes, display scenes, and allow interactive viewing. These programs exist as plugins for Internet Explorer and Netscape Communicator browsers and are available for free downloads. Teachers download and install the required plugin to prepare for this activity.

This design project presents open-ended problems to be solved within a major theme or framework. Teachers prepare a project description (design brief - see Appendix 1) that outlines the criteria for the design. Initial criteria are kept simple to allow students to grasp the mathematical concepts. Students initially take example files and modify the code to learn the structure. Teachers develop a project theme that allows separate teams or individuals to work on a small part of a greater whole. Sample project themes include:

- a simple geometric robot;
- cartoon-like characters or avatars;
- modules of a space station or Martian colony;
- simple buildings to be arranged in a community;
- rooms in a particular building, such as the school.

Through the modelling capabilities of VRML, students represent a wide variety of imagery of varying ethnocultural or religious backgrounds, and the local community. Teachers should look for project ideas that reflect Canadian and local community values and culture.

Students are made aware of the full design process, including identifying needs and criteria, researching current situations, proposing and analysing possible solutions, developing models, testing solutions against established criteria, and preparing analysis for further developments.

After analysing project requirements as outlined in the design brief, students sketch their proposals, using dimensioning to locate the relationship between parts. Students are introduced to pseudo code as a tool to organize their work. (Pseudo code is a literal description used as a framework to build code, such as "move 2 units in the x direction, make a red cylinder.")

Students analyse existing code line-by-line to understand its structure. Teachers help students analyse code of simple worlds as they work to become familiar with the structure and relationships between elements. Students take existing code and modify parameters until they master the code structure before moving to more complex concepts. Students build a vocabulary list.

Prior Knowledge Required

Participants have a working knowledge of computer operations such as word processing, creating graphics, printing documents, and managing files. Participants have some knowledge of Internet research and are familiar with computer usage regulations as defined at the local or board level. Students with expertise in computer operations may be paired with students less knowledgeable.

Since VRML can be used to model physical systems, almost any curriculum expectations outlined in the *Ontario Curriculum Grades 1-8 Science and Technology* document may be reinforced through virtual reality modelling. For example, particular project themes may be adapted from Matter and Materials, Structures and Mechanisms, and Earth and Space Systems. Teachers may also address topics selected from other curricula, highlighting the importance of integrating computer technology into the learning process. Virtual reality modelling integrates mathematical concepts such as co-ordinate geometry, logic, and measurement.

Teaching/Learning Strategies

This activity incorporates a variety of experiential learning strategies, including hands-on computer programming, implementing problem-solving procedures using the design process, communicating ideas through graphic design, presenting completed work, writing technical reports, and participating in group design activities. Students' individual work includes sketching and dimensioning, developing pseudo code, report writing, and researching, while group activities include brainstorming, making design decisions, and organizing duties. Students present the final product within their classroom, or with other classrooms or community groups.

Activity Instructions

1. Students experience the concept of virtual reality by examining sample worlds freely available through the Internet or on CDs. Teachers highlight the concept of modelling engineering, architectural, or scientific products or ideas, and the importance of this step in the design process. Teachers emphasize that modelling by computer is faster, cheaper, and more powerful than physical modelling. Students explore currently available virtual worlds and become familiar with the navigational controls of the virtual reality viewer.
2. Teachers assign students projects to be modelled in virtual reality. Students receive a project description (design brief), duty outlines for particular design teams (as required), deadlines for deliverables, and project assessment criteria.
3. Students use grid paper and CAD software or drafting tools to become familiar with the principles of co-ordinate geometry (XYZ axis, translation, and rotation of points in 3-D space). They construct objects using primitive geometry (spheres, cylinders, boxes, cones, and text) and define colour using RGB (Red, Green, Blue) values. Students draft code on paper using pseudo code.
4. Students analyse sample code line-by-line to identify key concepts of VRML code, such as case sensitivity, the use of comments and indentation to retain readability, placement of brackets, and the principles of object properties, transforms, and grouping.
5. Students analyse the requirements for their particular virtual reality model, brainstorm key concepts, produce sketches with appropriate dimensions, and write project proposals for teacher approval. An additional activity may include a session where students sell or "pitch" their ideas to the teacher and/or class.
6. Students edit and save files in a text editor, load files into the viewer, debug problems using trouble-shooting procedures, and generate code in a 'build-up' fashion for on-going testing.
7. Students produce their assignments to specifications outlined in the original design brief.
8. Students develop a technical report outlining the original goals of the design exercise, the design process undertaken, troubleshooting procedures followed (with results), and suggestions for further work. The report includes a printout of the code and a screenshot of the completed work.
9. Students demonstrate their completed projects to the class. Printouts of completed projects are displayed around the classroom or in a display case. Class discussions focus on how virtual realty modelling can be applied to other curricula, such as modelling molecules in Science, illustrating historical architecture in Social Science, designing sets for plays in drama, etc.

Assessment/Evaluation

	Level 1	Level 2	Level 3	Level 4
Understanding of concepts TFV.01X, TFV.04X, TFV.05X, SPS.02X, ICV.03X, ICV.04X	- demonstrates limited understanding of virtual reality programming or co-ordinate geometry concepts	- demonstrates some understanding of virtual reality programming or co-ordinate geometry concepts	- demonstrates considerable understanding of virtual reality programming or co-ordinate geometry concepts	- demonstrates thorough and insightful understanding of virtual reality programming or co-ordinate geometry concepts
Thinking/Inquiry TFS.01X, TFS.06X, ICS.05X, ICS.06X	- uses thinking skills to identify and solve problems with limited effectiveness	- uses thinking skills to identify and solve problems with moderate effectiveness	- uses thinking skills to identify and solve problems with considerable effectiveness	- uses thinking skills to identify and solve problems with high degree of effectiveness
Application of inquiry/design TFS.02X, TFS.04X, SPV.03X, SPV.05X, SPS.01X	- applies few strategies such as sketching, dimension calculation, and pseudo code generation	- applies some strategies such as sketching, dimension calculation, and pseudo code generation	- applies a variety of strategies such as sketching, dimension calculation, and pseudo code generation	- applies many effective strategies such as sketching, dimension calculation, and pseudo code generation
Communication of Information TFV.02X, TFS.03X, SPV.02X, SPS.03X	- communicates design ideas and finished products with limited clarity	- communicates design ideas and finished products with moderate clarity	- communicates design ideas and finished products with considerable clarity	- communicates design ideas and finished products with a high degree of clarity
Application of equipment, procedures and technology SPV.01X, SPS.04X, SPS.05X, SPS.07X, SPS.09X, ICV.05X, ICS.02X, ICS.07X	- uses procedures, file management strategies, and computer-related equipment correctly only with supervision	- uses procedures, file management strategies, and computer-related equipment correctly with some supervision - demonstrates limited knowledge of acceptable computer use policy	- uses procedures, file management strategies, and computer-related equipment correctly with minimal supervision - demonstrates some knowledge of acceptable computer use policy	- demonstrates and promotes the correct use of procedures, file management strategies, and computer-related equipment - demonstrates full knowledge of acceptable computer use policy

Diagnostic testing is recommended at the beginning of the activity to ensure that the teacher is aware of the level of prior knowledge of all students. Students are assessed at various stages of program development, designing, and reporting. Teachers conference with individuals and groups to assist in trouble-shooting any problems that develop. Peer- and self-assessment during presentations allow students to view all products and compare them in terms of quality and levels of difficulty. In addition, each student evaluates their own product based on the criteria set out by the teacher and/or class consensus.

Accommodations

Teachers may adapt this activity by varying the amount of research required, the degree of difficulty in project work, and the depth of detail of computer programming concepts covered. Teachers provide more guidance and/or allocate simpler designs for individuals with limited computer knowledge or who are experiencing difficulties with computer usage. Special needs students are paired with students who have more advanced knowledge or skills in computer applications, or are provided the opportunity to work with peripheral assignments such as constructing physical models of virtual reality designs, composing project-associated web pages, or designing and constructing posters. More advanced students may take advantage of the leadership opportunities provided through project manager functions.

Teachers may build enrichment activities/extensions by providing projects of increasing complexity involving animated elements or triangulated geometry. VRML 2.0 allows for the animation of objects and facilitates viewer interactivity using sensors, interpolators, and routing. VRML animation uses the concept of input, process, and output, where a sensor (such as a clock or a mouse click) is routed to an interpolator (such as one that defines colour, transparency, position, or rotational angle) which is then routed to an object to redefine its corresponding properties. Any matter of interactivity can be introduced, such as the blinking of lights, generation of sound, or opening of doors. VRML animation should only be attempted after the basic code is mastered.

Resources

Resources required for this activity include informational resources for VRML code samples and tutorials. Sources include libraries, booksellers, Internet sources, and teaching packages.

Web sites

A few of the many Internet resources include:
The VRML Repository (comprehensive list of resources, viewers, editors, tutorials)
http://www.sdsc.edu/vrml/

Cosmo Software (free VRML viewer plugin for most platforms and browsers)
http://cosmosoftware.com

Scotty's VR Shack (samples of student work, code guides, project ideas)
http://www.igs.net/mascott/vrml/vrtalk.htm

Books

Many books outline VRML coding. The book/CD considered essential is:
Ames, Andrea L, John Moreland, and David Nadeau. *The VRML 2.0 Sourcebo*ok. New York: Wiley and Sons, 1997. ISBN 0-471-16507-7 (see http://www.wiley.com/compbooks/ or http://amazon.com)

VRML Programming: Appendix

Programming virtual reality objects in VRML can be accomplished by assembling basic geometric primitives such as the sphere, the cylinder, the box, or the cone. For example, a robot head may be constructed using a box for the head, two spheres for eyes, a cone for a nose and a box for the mouth. Objects are placed within a scene by translating the XYZ co-ordinates before creating the object, where by default the positive X axis is to the right along the screen, the positive Y axis is toward the top of the screen, and the positive Z axis is toward the viewer. Note that primitives are placed at their centres by default. Characteristics such as colour are easily changed as well. Colour is defined as red, green, blue (RGB) values between zero and one, for example, 1.0 0.0 0.0 is bright red, where as 1.0 1.0 1.0 is white.

The strategy to teach VRML coding is to provide sample code that the student can then modify. A simple sample is illustrated below. Students practise editing by changing colour, geometric parameters such as height, or even the geometry. Note that the indentation and placement of brackets is for readability only, and is standard code formatting for programming languages such as Visual Basic, C++ or Java.

```
#VRML V2.0 utf8
# A simple pine tree, with brown cylindrical trunk and green cone top

Shape{
        appearance Appearance{
                material Material{
                        diffuse Color 0.8 0.5 0.2
                                }
        }
        geometry Cylinder{
                        radius 0.5
                height 2.0
        }
}

Transform{
        translation 0.0 2.0 0.0
        children Shape {
                appearance Appearance{
                        material Material {
                                        diffuse Color 0.0 1.0 0.0
                                 }
                }
                geometry Cone {
                        bottom Radius 2.0
                        height 4.0
                }
        }
}
```

Note that most causes for errors are missing or misplaced brackets, or the wrong case for letters. For more simple examples, see the resources mentioned in the VR Programming activity.

Unit 5: Hospitality and Tourism/ Health and Personal Services

Time: 22 hours

Unit Developer(s)

Deb Jago, Patricia Burns
Simcoe County District School Board: Lead Board

Development Date: July 1999

Unit Description

Students investigate four very different and distinct activities in the Hospitality, Tourism and Personal Services technologies, incorporating computer use into the activities. These activities may be conducted in any order. This unit helps students become aware of career opportunities, educational programs, and opportunities for co-operative education in the areas of Tourism, Hospitality and Personal Services.

Strand(s) and Expectations

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

Overall Expectations: TFV.01X, TFV.02X, TFV.03X, TFV.04X, SPV.01X, SPV.02X, SPV.03X, SPV.05X, ICV.01X, ICV.02X, ICV.04X ICV. 05X.

Specific Expectations: TFS.01X, TFS.03X, TFS.04X, TFS.08X, SPS.01X, SPS.02X, SPS.03X, SPS.04X, SPS.05X, SPS.07X, SPS.08X, ICS.01X, ICS.03X, ICS.05X, ICS.06X ICS.07X.

Activity Titles (Time + Sequence)

Activity 1	Create a Promotional Travel Brochure	330 minutes
Activity 2	Personal Grooming and Skin Care Procedures	330 minutes
Activity 3	Career Research Booklet	330 minutes
Activity 4	Planning a Theme Celebration	330 minutes

Unit Planning Notes

Teachers ensure all necessary references, equipment, and resources listed in each activity are available for students' use. Materials for review, activities, and research may be obtained from a variety of sources including web site addresses, school libraries/resource centres, and public libraries; as well, teachers should become familiar with computer programs available to the students. Students and teachers benefit from contacting local businesses in the Hospitality, Tourism, and Personal Services industry for support in conducting the various activities. These community members provide students with insight into career opportunities and education requirements, and potentially offer students co-operative education learning opportunities in Grades 11 or 12. Teachers perform the activity before implementation to familiarize themselves with all necessary safety considerations and to ensure that all facility, equipment and material requirements are available.

Prior Knowledge Required

Students know how to operate some computer programs, open, save and exit as a minimum requirement. By Grade 8, students have learned to communicate procedures and results of investigation for specific purposes to specific audiences, using a variety of mediums, including written notes, drawings, and oral presentations. For the skin care activity students describe the organization of cells into tissue, organs, and systems; and describe the needs and functions of various cells and organs in relationship to the need of the human body as a whole. In all technology facilities students know safe and sanitary procedures.

Teaching/Learning Strategies

This unit incorporates a variety of teaching and learning strategies, including teacher-directed activities, individual learning activities, group work, and co-operative learning strategies. The teacher provides students with the information, resources and guidance necessary to complete each task safely with maximum opportunity for success. Students are provided with opportunities to work independently and in groups to perform the following tasks: problem solving, brainstorming, report writing, assessing projects, and making classroom presentations. Activities should be modified to meet the needs of all learners by applying various accommodations, such as: allowing increased time for activities, enhancing or compacting content, assisting during evaluation processes, and facilitating peer-tutor assistance where possible.

Assessment/Evaluation

Methods of assessment and evaluation include a wide variety of approaches to enhance student learning. Assessment methods include: student-designed assessment criteria, performance assessments such as projects and skill demonstrations, personal communication, assessment processes such as instructional questions and answers, conferences, classroom discussions, journals, or log books, and standardized tests such as classroom tests or examinations. Each activity contains a sample rubric for assessment, which may be used by the teacher and/or student.

Resources

Resources required for this unit include: computers equipped with word-processing software, graphics software, Internet facilities, cooking equipment, groceries (optional for facial), a colour printer, and skin care products. Furthermore, each activity contains references to information such as researched web site addresses.

Activity 1: Create a Promotional Travel Brochure

Time: 330 minutes

Description

Students follow a design process (see Appendix 1) to create a travel brochure that promotes tourism in their local community or region. As students research and gather information for the brochure they identify the roles of hospitality and tourism sectors in their own community and related career opportunities. In developing the brochure students enhance their communication skills using a variety of mediums while reflecting on the unique qualities of their own community or region. Students select a target audience for the brochure (usually visiting families with school aged children).

Strand(s) and Expectations

Strand(s): Theory and Foundation, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.02X, SPV.03X, IC1.07X.
Specific Expectations: TFS.01X, TFS.03X, TFS.08X, SPS.01X, SPS.03X, SPS.04X, SPS.07X.

Planning Notes

Gather samples of brochures from sources such as the local Chamber of Commerce, travel agencies, and government tourism offices to help students research local hospitality and tourism attractions and opportunities in their community. Many large hotels and resorts display brochures of local attractions. Students refer to historical or geographical references to gather information on local attractions. Students

use these collected brochures to identify local attractions as well as analyse features of a well-designed brochure.

Students develop (or are provided) a list of characteristics of an effective brochure, along with the physical specifications of the finished copy (e.g., letter-sized paper). Students who have not used a computer program receive handouts illustrating the tools and features of programs such as *CorelDRAW*™, *WordPerfect, Microsoft Word,* and *Microsoft Publisher*. Provide sample brochures to illustrate common features and help clarify the task for learners who need additional guidance and concrete examples. Teachers confirm in advance what materials and processes are available for students to research, design, and produce their brochures. Brochure development may involve components such as visits to local attractions, Internet access, and the use of computer graphic equipment and software, photocopiers, paper, coloured papers, etc.

Computer equipment recommended for brochure development include computers with *CorelDRAW*™, *WordPerfect, MS Word,* or *MS Publisher*, and a printer (colour capabilities offer more design options). Optional but not essential equipment includes a scanner, digital camera, and video camera (to show students local features of interest).

Prior Knowledge Required

Participants know how to open, save, and exit computer programs. By the end of Grade 8, students have learned to communicate procedures and results of investigation for specific purposes and to specific audiences using a variety of mediums, including written notes, descriptive drawing, and oral presentations. Students are aware of the design process.

Teaching/Learning Strategies

Teachers provide students with examples of brochures from a number of different sources. They discuss and analyse the materials. The class participates in a brainstorming session to identify what makes the brochures effective as marketing tools. Teachers introduce elements of design at this point (see Appendix 1). Discussions about the use of white space, rhythm, balance, and fonts help students as they design their own brochures. Teachers may refer to the Memo Pad activity for specific information about the graphic design process.

Students research tourism opportunities in their community by accessing telephone directories, family and friends, municipal and provincial hospitality and tourism offices, local attractions, etc. Students may also visit local tourist venues, including hotels, restaurants, and attractions, to speak with members of the industry. They use a wide variety of research materials, including school and community libraries, the Internet, the local Chamber of Commerce, the Visitor and Convention Bureau, and local community figures. Teachers emphasize the procedures students must follow in order to use the Internet appropriately.

Students follow a design process as they clarify the challenge of developing a promotional brochure. Participants research local hospitality and tourism opportunities, generate a number of thumbnail sketches and rough drawings, prepare a comprehensive drawing of their selected design, and prepare the final brochure. Students evaluate the final product to determine if it meets the challenge of promoting their community. Teachers expand, reduce or eliminate stages of the design process to accommodate learners with varying abilities.

Activity Instructions

1. Students examine a variety of brochures showing any number of attractions. They study these examples to determine elements they wish to incorporate into their own brochure designs. Students record characteristics of effective promotional brochures in their notes, in consultation with their teacher.
2. Students examine elements of design important in the production of an attractive printed piece. Students review computer programs to observe brochure templates and understand how a brochure is formatted. Teachers demonstrate how to use a scanner, import clip art images, draw lines, etc. using a variety of programs. Students select a program to produce their own brochure. Students record in their notes the design elements that must be incorporated in their promotional brochures. These criteria are used to determine the most suitable design.
3. Students research their community's characteristics and attractions and gather information and pictures to potentially include in the production of their brochures. Students focus on the area's historical, cultural, geographical, and entertainment attractions using any number of sources as described above. Preliminary copies of the student brochures are hand- or computer-generated with written text, graphic images, colours, clip art, etc.
4. Students write a proposal for their brochure, clearly outlining the community aspects to be highlighted, the intended audience, and a list of skills and knowledge that are acquired or enhanced. Students identify the selected computer program, size of paper, colour of paper, and images, and provide the rationale for choosing these components. Teachers review and approve the students' choices to ensure the best chance for success. Teachers consider students' prior experiences in creating graphic designs as they assess proposals.
5. Students prepare four thumbnail sketches of different brochure designs. These thumbnail sketches meet previously established criteria for an effective brochure (see step 1).
6. Students critique their thumbnails and choose the best two to develop further. Teachers may enhance this step by asking students to share their design ideas with a local community member who works in the hospitality or tourism sector. Students record the individual's comments and suggestions and include these in the design report.
7. Students create full-size roughs, improving the initial designs by incorporating suggestions from other students, teachers, and appropriate community representatives.
8. Students choose the best design and create a full-size, coloured comprehensive.
9. Using the comprehensive as a guide, students create their brochures with a computer. Students may produce brochure finals using school resources or those available in the local community. This production stage provides students with an opportunity to delve into the possibilities of co-operative education placements in community businesses.
10. Students produce a design report, including their thumbnails, roughs, and comprehensives, and an evaluation of the project design process. The design report also includes: a problem statement, required criteria for developing effective brochures (see steps 1 and 2), a description of why a particular design was selected, a method to assess the brochure (see Assessment/Evaluation), and suggestions for improvement if the brochure were to be updated and revised for a second print run.

Assessment and Evaluation

	Level 1	Level 2	Level 3	Level 4
Knowledge/ Understanding TFV.01X	- demonstrates limited understanding of design concepts	- demonstrates some understanding of design concepts	- demonstrates considerable understanding of design concepts	- demonstrates thorough and insightful understanding of design concepts
Thinking/Inquiry TFS.01X SPV.03X SPS.01X SPS.04X	- uses thinking skills with limited effectiveness	- uses thinking skills with moderate effectiveness	- uses thinking skills with considerable effectiveness	- uses thinking skills with a high degree of effectiveness
Communication TFV.02X TFS.03X TFS.08X PS.03X	- communicates to potential visitors with a limited sense of audience	- communicates to potential visitors with some sense of audience	- communicates to potential visitors with a clear sense of audience	- communicates to potential visitors with a strong sense of audience
Application SPS.07X ICS.07X	- makes connections between school and the community with limited effectiveness	- makes connections between school and the community with moderate effectiveness	- makes connections between school and the community with considerable effectiveness	- makes connections between school and the community with a high degree of effectiveness

Students demonstrate appropriate use of computers and generate their brochures to meet the required design criteria. The proposal follows the teacher-outlined format. The design report (see Appendix 1) reflects each stage of the research and design process. In the evaluation phase representatives of the local tourism sector may be invited to a formal presentation of the students' design ideas and completed brochures. The invited guests could then provide feedback to the students. Ideally, these community representatives assist students at various stages throughout the research, design, and development of the brochure. The design proposal should be in correct format and include the design brief. Students produce a minimum of four different ideas on their thumbnails. All thumbnails should meet the criteria and agree with the students' proposals. Roughs and comprehensive drawings show development and refinement of design ideas. The comprehensive should be neatly and carefully finished, duplicating the text styles and graphics closely. Students also describe the environmental, ecological, economic, and social impact of increased tourism in their area.

Accommodations

Teachers provide templates for students who experience difficulty visualizing designs. A design report template provided by the teacher helps students write a report by filling in the blanks. Alternative activities are proposed for students who have difficulty communicating. These students may cut and paste material from brochures used as resources in the initial stages of the activity to produce a collage illustrating a number of local attractions. The collage could be used as a research tool in other brochure design sessions. Teachers may extend activities by having students use a digital camera to capture images of local attractions and then edit and insert those images into their brochures. In addition, students may help create a tourism web page for their community. These students could use their brochures as the basis for the web page and add more information as needed. Students may conduct additional research within the tourism industry in their community and make a presentation to their local visitor and convention bureau or municipal council meeting to identify effective means of expanding tourism.

Resources

Samples of brochures available at the chamber of commerce (where available), travel agencies, hotels, resorts, etc.

Computers and printers as well as handouts about the graphics software to be used (*CorelDRAW™*, *WordPerfect, MS Word,* and *MS Publisher*)

Paper of the selected type and colour.

Useful but not essential equipment includes scanner, digital camera, and video camera.

Activity 2: Personal Grooming and Skin Care Procedures

Time: 330 minutes

Description

Students discuss grooming, personal hygiene, and healthy lifestyles. Students work with each other to analyse their skin types and determine which types of products would be beneficial to their own skin. Discussion also focuses on the purposes of each product, and its application and removal procedures. Students conduct an Internet search for information about grooming products and ingredients for home-made facials. Each member of the class receives a skin cleansing treatment and facial mask using available products.

Strand(s) and Expectations

Strand(s): Theory and Foundation, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.04X, SPV.05X, ICV.01X, ICV.02X, ICV.05X.
Specific Expectations: TFS.04X, SPS.03X, SPS.07X, SPS.08X, ICS.01X, ICS.03X, ICS.05X, ICS.07X.

Planning Notes

- Prepare a one-page student handout for a step-by-step facial procedure.
- Share the assessment of the activity with the students.
- Purchase skin care products such as cleansers, toners, scrubs, masks, and moisturizers for different types of skin;(inexpensive drug store products allow students to experiment with items readily available for purchase at a later date if they wish to continue a skin care routine at home).
- Have a camera ready, as students with interesting products on their faces makes for a great photo opportunity.
- Ensure sanitary measures are followed by asking students to bring a clean washcloth and small towels from home on the day scheduled for the facial.
- Have sanitized towels, tissues, and facial sponges available for student use.
- Students with problem skin are referred to a doctor. Teachers are aware of cultural practices that may necessitate different arrangements for some students.

As an extension to the regular activity, teachers challenge students to create their own facial masks, using fresh groceries supplied by the teacher. Students research the skin care requirements of various skin types, and formulate a mask that would suit the particular skin type. Furthermore, teachers invite a local qualified guest to demonstrate a professional facial for the class and answer students' questions about skin conditions.

Prior Knowledge Required

Participants have knowledge about: the organization of cells into tissue, organs, and systems; the needs and functions of various cells and organs in relationship to the need of the human body as a whole; school policy for acceptable Internet use and Internet research skills; the importance of following safe and sanitary procedures at all times; sanitary procedures for items and tools to be used; sanitary precautions for application and use of products; positive communication with peers (required in particular during personal skin analysis and facial procedure); and the importance of positive interaction with peers, especially with the potential closeness and touching of classmates faces.

Teaching/Learning Strategies

Students discuss the importance of good grooming, personal hygiene, and a healthy lifestyle. The class focuses on issues such as bathing, skin and hair care, diet, and exercise. Students discuss a variety of personal concerns and teachers respond by leading the discussion towards potential solutions to help correct the noted problems (for example, acne, shaving, and the effects of sun). Students share suggestions and discuss methods or products that have been successful for them. Students with problem skin are referred to a doctor. Discussion includes some of the myths about problem skin and hair. (Teachers may introduce the concept of professional image in service-related occupations, or use this opportunity to counterimage stereotyping of people based on appearance and physical characteristics.)

The following activity focuses on skin care but may also include other personal grooming areas. Teachers ask students if they know their skin type and, if so, to describe the features which define their skin within a specific category. Teachers inform students about the characteristics of various skin types. Students may be asked to visit a cosmetic counter and request that a skin care professional assess their skin type and recommend a daily skin care routine. Students are also made aware of potential sales efforts. Before students analyse each other's skin, teachers emphasize that positive communication and feedback are absolute necessities during this stage of the activity. Diplomacy is highly encouraged as some students may have problem skin and students in this age group may be particularly self-conscious about their appearance. Organized in groups of four or five, students analyse the skin of fellow group members to

determine skin types. Students discuss reasons for their decisions. Each group shares their findings with the entire class. Teachers confirm students' decisions and ensure each student is aware of his or her skin type. If necessary, teachers review basic Internet research skills before students access the computer lab to obtain information about personal care products, their purposes, and usage procedures. Home-made facial ingredients may be researched as well. The completed research assignment includes names of products, purposes, application methods, timing, and removal procedures. A prize may be awarded to the student who finds the most natural products to use as skin care ingredients or to the student who finds the most related web sites.

Research may be expanded to include magazine and book resources. Teachers collect the research material and organize the appropriate information. A discussion of students' research highlights natural products that could be used in the facial procedure. This information helps determine which natural ingredients to purchase in preparation for the facial treatment. Each student receives one skin care product and reads the label and directions. Students share this information with the class and discuss the use of each product. Participants determine which product would be appropriate for their particular skin type. Teachers display all of the products, explain product groupings, and review the purposes and proper uses of products. Teachers described draping procedures, application methods, amounts of product needed, recommended massage movements, application time limits, and removal methods. The importance of working in sanitary conditions is stressed. Information sheets about facial procedures are distributed to the class and, for homework, teachers may ask students to prepare a brief summary of the procedure described in the handout. Fresh products are purchased on the day of the facial treatment. Spoons, a knife, and bowls are available for students to prepare and combine the ingredients of home-made facials. Required products are organized to avoid confusion and to ensure they are easily accessible. All the masks are placed on one desk to save time and facilitate student discussion of product choices and comparisons of labels and instructions.

Teachers may choose to:

a) demonstrate the facial procedure and invite students to ask questions during the process;
b) have students give themselves a facial by following written instructions or procedures explained on video;
c) allow students to give each other a facial step-by-step with teacher guidance;
d) invite a professional to provide a class demonstration and answer students' questions.

Assessment and Evaluation

	Level 1	Level 2	Level 3	Level 4
Knowledge/ Understanding TFV.01X ICS.03X	- demonstrates limited knowledge of skin care facts and facial procedures	- demonstrates some knowledge of skin care facts and facial procedures	- demonstrates considerable knowledge of skin care facts and facial procedures	- demonstrates thorough knowledge of skin care facts and facial procedures
Communication TFV.04X SPS.03X SPS.07X ICV.02X	- communicates information to client/classmate with limited clarity	- communicates information to client/classmate with moderate clarity	- communicates information to client/classmate with considerable clarity	- communicates information to client/classmate with a high degree of clarity, and with confidence
Thinking/Inquiry TFS.04X ICV.05X ICS.05X ICS.07X	- uses thinking skills with limited effectiveness	- uses thinking skills with moderate effectiveness	- uses thinking skills with considerable effectiveness	- uses thinking skills with a high degree of effectiveness
Application SPS.08X ICV.01X ICS.01X	- uses facial procedures safely and correctly only with supervision	- uses facial procedures safely and correctly with some supervision	- uses facial procedures safely and correctly	- demonstrates and promotes the safe and correct use of facial procedures

Teachers use formative assessment to assess procedures followed, Internet research skills, analysis of skin type differences, proper product use, facial procedure steps, recommended sanitary methods, and sample case studies.

Accommodations

Students with special needs may require assistance, and if it is difficult for them to provide a facial for someone else they are encouraged to give themselves a facial. Students uncomfortable with a peer touching their face may give themselves a facial. Teachers inform the class about the possibility of these situations arising and encourage an atmosphere of acceptance and understanding. Teachers need to be aware of the potential for allergic reactions; a questionnaire is distributed to all participants asking specifically about allergies to natural products (i.e. peanuts, eggs).

Resources

Books

Miladys Standard Textbook of Cosmetology. Milady Publishing Company. (Canadian Distributor - NP Group 1220 Ellesmere Road, Unit 19, Scarborough, Ontario M1P 2X5, Phone: 416-291-8057 or 1-800-267-4247; fax 416-291-2723.) ISBN 1-56253-200-6

Gerson, Joel. *Miladys Standard Textbook for Professional Estheticians*. Milady Publishing Company. (See above) ISBN 1-56253-200-7

Video

Facial Treatment videotapes Education Series. Volume 1: Basic Facial Treatment; NP Group (see above): order # 156253386-x

Web sites

http://www.delmar.com/delmar.html; info@delmar.com

Product line web sites:
www.clinique.com
www.aveda.com
www.revlon.com
www.clearasil.com
www.biore.com
www.dior.com
www.lancome.com

Homemade facial sites
www.honey.com/recipes/beauty/index.html
www.foxhollowherbs.com/hand_crafted_herbal_soaps.htm
www.healinggarden.com

Skin care tips
http://fitcamp.com/articles/skin10ab.html

Activity 3: Career Research Booklet

Time: 330 minutes

Description

Students research various careers within a given professional field, select a career of interest, and create an information booklet about their chosen career. Enrichment activities include creating a poster to promote the selected career and providing a presentation about the career to the entire class. The activity outlined below focuses on careers in personal services but any professional field may be researched.

Strand(s) and Expectations

Strand(s): Theory and Foundation, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.02X, TFV.03X, SPV.03X, SPV.05X, ICV.04X, ICV.05X.
Specific Expectations: TFS.03X, TFS.04X, SPS.02X, SPS.04X, SPS.05X, ICS.06X, ICS.07X.

Planning Notes

- Research various personal services careers such as hairstylist, Registered Practical Nurse (RPN), physical therapy assistant, child care worker, ambulance attendant, flight attendant, makeup artist, dental assistant, paramedic, etc.
- Prepare a web diagram showing the occupations.
- Become aware of computer-based programs in the school and community that are specifically designed for career research (Career Center, Guidance Office, Learning Resource Centre, etc.).
- Understand Internet research skills.
- Review and incorporate co-operative learning strategies.
- Prepare a detailed assignment sheet outlining the tasks, processes to be followed throughout the research project, and Assessment/Evaluation criteria.
- Schedule an introductory seminar in the library or career centre where students will be conducting research.

Prior Knowledge Required

Participants know how to open, save, and exit a computer program. By Grade 8, students have learned to communicate procedures and results of investigation for specific purposes and to specific audiences using a variety of mediums, including written notes and oral presentations.

Teaching/Learning Strategies

1. Teachers introduce personal services careers in a class discussion. Teachers draw a web diagram with four personal services areas - childcare, geriatrics, health care, and grooming - on the board or an overhead transparency. During a brainstorming session students suggest various careers in each of the four areas. Teachers record and categorize the suggested careers in the appropriate areas. Students complete their own copy of the information. Conducting a research assignment provides students with their first source of information.
2. Students choose one occupation that interests them. Teachers ensure that all four areas are selected within one class so that students are introduced to a variety of professions during final presentations.
3. Students work in groups of two or three, and a number of groups work on a similar career area. Students who prefer to work alone on a career are given the option of joining a group for a portion of the assignment and then completing the final report alone.
4. Teachers review positive learning aspects of co-operative learning with the class and obtain feedback about the recommended best approach. Teacher-selected groups ensure expertise and skills are equitably distributed.
5. Students maintain a learning log of activities and time spent during the research assignment stage. Students submit this log with their final assignment.
6. Groups discuss time management, division of responsibilities, and how to be the most productive. Students plan strategies for dividing research tasks equitably and ensuring every member's strengths and skills are used. It is not recommended to appoint group leaders.
7. Teachers and students discuss areas that would be important to research when exploring a career. These areas include educational requirements, training organizations, projected salaries, job descriptions, growth potentials, employment outlooks, and availability of jobs.
8. In a computer lab (or in groups at one computer) students search for appropriate web sites relating to their chosen profession. Teachers review Internet research skills and the school's code of agreement. Students explore and problem solve before teachers provide them with several web sites dedicated to

providing career information (see Resources). Teachers add new student-discovered web sites to their growing list of useful Internet sites for future projects.

9. When Internet access is limited, other sources of career information include the Career Cruising compact disc, National Occupational Classifications (NOC), Guidance Centre Career Monographs, Choices, and Career Explorer.
10. Students may interview a professional in the field they have chosen. Students design an interview package, including target interviewees, interview questions, length of interview, and how the results of the interviews are communicated to the audience. Teachers review interviewing skills, potential interview questions, and appropriate interview lengths.
11. Students compile and edit their material. They then organize the material into a booklet. The booklet includes a creative cover page with computer graphics, an essay describing the career information from all sources, a log detailing how student time was spent on the project, actual printout pages from the Internet (highlighted to show the main points), and the names of each group member with their area of responsibility. Students may also create a poster reflecting some aspects of the profession and refer to the poster during final presentation to the class.
12. Each group presents their findings to the class. In this way, students are introduced to information about a variety of personal services careers. Peer-assessment is completed on a separate form as they share the results of their assignment.

Assessment and Evaluation

	Level 1	Level 2	Level 3	Level 4
Knowledge/ Understanding SPV.05X ICV.04X ICS.07X	- demonstrates limited knowledge of facts, procedures, and standards	- demonstrates some knowledge of facts, procedures, and standards	- demonstrates considerable knowledge of facts, procedures, and standards	- demonstrates thorough knowledge of facts, procedures, and standards
Thinking/Inquiry TFV.03X TFS.04X ICS.06X	- applies few of the skills involved in an inquiry process	- applies some of the skills involved in an inquiry process	- applies most of the skills involved in an inquiry process	- applies all or almost all of the skills involved in an inquiry process
Communication TFV.02X TFS.03X SPS.02X	- communicates career information with a limited sense of audience and purpose	- communicates career information with some sense of audience and purpose	- communicates career information with a clear sense of audience and purpose	- communicates career information with a strong sense of audience and purpose
Application SPV.03X SPS.04X SPS.05X ICV.05X	- makes connections between school and career choices with limited effectiveness	- makes connections between school and career choices with moderate effectiveness	- makes connections between school and career choices with considerable effectiveness	- makes connections between school and career choices with a high degree of effectiveness

Formative evaluation is ongoing throughout the entire activity. This includes student-teacher conferencing, appropriate computer use, and quizzes on good interview questions. The culminating event occurs when students present the career information to the class, at a career fair, or during a career-related event. Summative evaluation includes individual, peer, and teacher assessments. Teachers review the criteria and

areas of assessment with students before the activity begins. Each student assesses group members using similar criteria. A self-assessment tool may also be used. The completed booklet includes: a cover page containing group members' names, the career name researched and a related graphic; an essay describing career information obtained from all sources; a log detailing how each group member spent his or her time working on the project; and an appendix containing any relevant information such as interview notes or sample printout pages from the Internet (highlighted to show the main points). Students assess their peers on a separate form, focussing on information contained in the completed booklet as well as in the presentations.

Accommodations

Students who may experience difficulty, are encouraged to find web sites, prepare the cover page, or create the poster for their group rather than edit written material. All students are encouraged to present with the help of their peers. Teachers may divide students into groups, and take into consideration strong art and computer skills. If they wish, students with physical disabilities may choose to focus their research on careers with physical requirements that blend well with their own physical abilities. Teachers may enrich the activity by having students create a *Power Point* presentation to explain the material.

Resources

CD-ROMs

Ministry of Education and Training. *Career Cruising.* (CD-ROM sent to Guidance offices).

Ministry of Education and Training. *Choices*.

Web sites

Career Explorer (Internet access through MET, sent to Guidance offices)
www.cx.bridges.com

Job Futures (Internet access)
www.hrdc-drhc.gc.ca (suggestion: go to site map, labour market information, and job futures)
www.careers.ocas.on.ca
http://jobsmart.org/tools/career/spec-car.htm
http://stats.bls.gov/oco/oco1000.htm
http://www.aboutwork.com/career/alphasearch.html

Guest speakers from the local community.

Activity 4: Planning a Theme Celebration

Time: 330 minutes

Description

Students follow a design process to plan and carry out a class celebration. Family members and/or teachers and other staff members are invited to share in the activity. Students establish a suitable theme, budget, and menu, as well as produce invitations and food for themselves and their guests.

Strand(s) and Expectations

Strand(s): Theory and Foundation, Skills and Processes, Impact and Consequences
Overall Expectations: TFV.01X, TFV.02X, SPV.01X, SPV.02X, ICV.01X, ICV.05X.
Specific Expectations: TFS.01X, TFS.03X, TFS.04X, SPS.02X, SPS.03X, SPS.08X, ICS.01X, ICS.03X.

Planning Notes

Students may plan this event as the culminating project for the unit - one that brings together various aspects of the course, such as menu planning, food purchase, food preparation, and presentation of food. For example, organizers may display a range of student projects completed during the school year and show videotapes of class activities and students working together. This relaxed forum encourages students to reflect upon the new skills and knowledge they have acquired. Organizers may choose to relate the celebration to a school event, such as a Grade 8 Night or a graduate luncheon. The celebration may be tied into other course work (for example, a party is organized with a World War II Flying Aces theme to reflect a recent study unit on gliders and flight).

Students begin the process of identifying a suitable theme by researching magazine articles or books that illustrate a variety of party themes. Cookbooks or textbooks containing a variety of recipes are also good resources. Encourage students to bring favourite recipes from home that they would like to share with the class. Teachers also encourage students to select foods with a multicultural flavour, as well as to become aware of cultural differences and allergies within the group who attend the celebration. Students include foods from all food groups. Examples of invitations from party shops or printers illustrate the many different ways invitations can be prepared. Material, produce, and supply requirements are determined after the final theme and menus are developed. This activity requires cooking equipment, computers with software for creating invitations, Internet access to facilitate e-mailing the invitations (if feasible), and a printer (preferably with colour capabilities to offer more design options). Potential cooking areas include Family Studies rooms, school kitchens, or staff room facilities. When cooking facilities are not available, students may design the menu to include cold foods or foods that can be microwaved. In the absence of computer graphics equipment, invitations and menus may be hand-drawn in collaboration with the art department.

Prior Knowledge Required

Participants know how to open, save, and exit a computer program. By Grade 8, students have learned to communicate procedures and results of investigation for specific purposes and to specific audiences using a variety of mediums, including written notes, descriptive drawings, and oral presentations. Students must be able to demonstrate safe working procedures, specifically measuring, weighing, using various pieces of equipment, and practising safe and approved food handling methods.

Teaching/Learning Strategies

Teachers provide students with a number of resources outlining party planning and theme parties or foods of other cultures. Students become sensitized to cultural differences in relation to foods. Elements of design are reviewed. The class discusses use of white space, rhythm, balance, and fonts as students design their invitations and menus. Students conduct research regarding the celebration theme and appropriate foods.

They use a wide variety of research materials, including but not limited to the school library/resource centre, the community library, community members, CD-ROMs, and the Internet. Teachers emphasize appropriate use of the Internet and ensure students understand techniques to avoid venturing into undesirable web sites. Working in groups of three or four, students follow the design process and prepare a proposal for their celebration. Students prepare their invitations and, if appropriate, menus for the party using thumbnail sketches, rough drawings, and finally full-size colour comprehensive drawings. Groups present proposals to the class. The class chooses one proposal for the celebration and to determine the party menu. Peer-assessment of the group’s working process that went into preparing their proposal as part of their formative assessment and their illustrations created to depict their group's theme.

Activity Instructions

1. The class selects one proposal/theme. Students determine the purpose for a celebration. In selecting the theme, teachers are aware of student sensitivities regarding cultural or religious differences in the class. Students conduct research to determine the suitability and history of the particular celebration being considered. Simultaneously, students determine how the theme is reflected through invitations, decorations, and food. A suitable date for the celebration is determined and facilities are booked.
2. Students write a proposal for the party following the teacher's outlined format (for example, business memorandum style). The proposal outlines details of the celebration and lists the skills and knowledge required to complete the project.
3. Students examine the elements of design as it relates to the creation of their invitations for family members or teachers and other staff members. Each student designs his/her own invitation. Students select the computer program they wish to use to create their invitation.
4. In groups, students research potential foods that could be prepared to serve at the celebration, keeping in mind the selected theme and various cultural differences. Recipes are word-processed for distribution to the class via e-mail. Teachers ensure the selected menu is achievable with the available facilities and students' skills in food handling and preparation. Teachers and students approve final menus. Students examine the stock in the classroom and make shopping lists to include produce and supplies still required. Orders are placed.
5. Students send invitations to invited guests using conventional mail, e-mail, and personal delivery.
6. Students create room and table decorations corresponding to their theme. Decorations may be computer-generated, using a scanner, digital camera, or suitable clipart, or they may be hand-made from materials found in collaboration with art classes, brought from home, or purchased.
7. Selected students accompany the teacher to the grocery store to purchase required food. Teachers emphasize comparison shopping and seeking value for money. Students involved in the shopping trip later describe to the class why they chose particular brands and types of ingredients.
8. In groups, students prepare the food in the school kitchen (or other suitable location) and store it properly until service time. Prior to handling, preparing, or storing food for consumption, teachers carefully review all key food handling safety precautions. This review focuses on the wearing of proper clothing and hair nets, hand washing techniques, optimum food temperature conditions, recommended cooking times and temperatures, and safe storage processes and temperatures. Teachers invite a guest speaker from the local health department to help students understand the importance of safe food handling techniques.
9. Students decorate the room and welcome their invited guests on the day of the celebration. Food is attractively displayed and served. Students may wear attractive uniforms or clean white smocks to enhance the serving process.
10. Students clean up the room and preparation areas during and following the celebration. The clean-up routine and process are planned and co-ordinated before the event begins. Advance planning ensures the entire event runs smoothly.
11. Students create a follow-up one-page report to reflect on the experience, noting problems encountered and suggestions for eliminating these problems and improving the celebration.

Assessment/Evaluation

	Level 1	Level 2	Level 3	Level 4
Knowledge/ Understanding TFV.01X ICV.05X ICS.01X ICV.03X	- demonstrates limited knowledge of facts, technical terminology, procedures, and standards	- demonstrates some knowledge of facts, technical terminology, procedures, and standards	- demonstrates considerable knowledge of facts, technical terminology, procedures, and standards	- demonstrates thorough knowledge of facts, technical terminology, procedures, and standards
Thinking/Inquiry TFS.01X TFS.04X	- 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 TFV.02X TFS.03X SPV.02X SPS.02X SPS.03X	- communicates information with limited clarity	- communicates information with moderate clarity	- communicates information with considerable clarity	- communicates information with a high degree of clarity and confidence
Application SPV.01X SPS.08X ICV.01X	- uses food handling procedures, cooking equipment, and technology safely and correctly only with supervision	- uses food handling procedures, cooking equipment, and technology safely and correctly with some supervision	- uses food handling procedures, cooking equipment, and technology safely and correctly	- demonstrates and promotes the safe and correct use of food handling procedures, cooking equipment, and technology

Performance assessment is on-going throughout the activity, including food handling safety (quizzes and application), organizational charts, student-teacher conferencing, creation of menus and invitations, and presentation of food. Summative evaluation takes place at the celebration, self-, peer-assessment and teacher evaluation.

Accommodations

Teachers may provide templates for students who experience difficulty with the design process. A memorandum template helps students write a report by filling in the blanks. Pairing students for many parts of the activity compensates for strengths and weaknesses.

Projects may be modified to suit specific strengths of students with special needs. For example, invitations may be created using pictures cut from magazines and pasted to cards. Modifications should be based specifically on students' Individual Education Plans. Teachers may extend activities by asking students to conduct further research to compare and contrast Canadian culture with other cultures. Students choosing a theme that reflects an area being studied in another class (refer to the comment about a study unit on flight and gliders in the Planning Notes) can undertake further research to amplify their understanding of the topic.

Resources

- facilities suitable for food preparation as determined by the menu selected;
- cooking equipment required for the selected menu;
- computers with software for creating invitations and with Internet access to facilitate e-mailing the invitations (if feasible), and a printer (colour capabilities offer more design options);
- art department supplies for sketching and drawing if computer graphics equipment is not available;
- access to the school library, the community library, community members, CD-ROMs, and the Internet;
- volunteers from within the school or local community to help students prepare food;
- a guest speaker from the local health department to explain how to handle food safety.

Appendix 1: Description of Design Terms

Model

The purpose of model making is frequently misunderstood. Models are not the end product of the technological process. They are miniature representations of ideas. Designers/creators/innovators use models to:

- communicate their initial ideas to others;
- work out their ideas.

A model can be 2-dimensional–as in layouts, drawings, or charts, or 3-dimensional–as in 1/4 or 1/2 scale models. Materials used in 3-dimensional scale models are different than the real materials of the final product. Different technical fields use different types of models. For example, the graphic design field could use a 2-dimensional model to illustrate ideas for a business card, or use a 3-dimensional model for a cereal box. The manufacturing field could use 2-dimensional technical drawings or 3-dimensional scale models made of model-making materials to represent the product idea. A 3-dimensional model is not always required as part of the design process.

Prototype

A prototype is quite different than a model. It is a full-scale representation of the product that uses the actual product material and technique. In real life, several prototypes may need to be developed before the final product idea is completely worked out. In school programs, there is usually time for only one prototype to be made, but at least it is tested, and students reflect on and document potential improvements.

Portfolio

The portfolio is a collection of all rough work completed during the development of the product prototype. Examples of items that can be included are journal notes or thoughts, time logs or sheets, telephone calls, meetings, scribbles, rough estimations, orders, bills, rough sketches, notes from meetings, and photographs of the product development. A portfolio can be created using a variety of different sorting devices, for example, a binder, a folder, or a box. Whatever sorting device is used, it should be organized into sections that represent the design process through which the product was developed. An index or tabbed dividers are helpful for this purpose. The portfolio is what the designers/creators/innovators use to document their work *for their own purposes*. In a school setting, the portfolio is assessed to determine if students are engaged fully in all aspects of a design process.

Design Report

The design report is produced from the information in the portfolio. It is a clean report of the development of the product. Again, it is organized around the stages of the design process that were used. Its purpose is to communicate the development of the product *to others*, such as the teacher or a potential client. If possible, it is produced using computer technology for both text and drawings. It can be produced simultaneously with the portfolio as each design stage is complete. If both a portfolio and report are used, the report is considered the last section of the portfolio.

Teachers may require students to complete either the portfolio or the report, or both. Class time, teacher and student skill levels, and the specific technological problem at hand whether it is service or design, course planning, and course organization affect this decision.

Appendix 1: Description of Design Terms (Continued)

Open-ended Problem Solving and the Design Process

The steps or techniques in solving a problem are known as the problem-solving process. In technological education, *when design - not service - is the focus*, the problem-solving process is called 'the design process'. At the beginning of the design process, students analyse a given set of conditions in order to identify a problem, challenge, or need. They then work through a number of identifiable stages in order to arrive at a solution.

Design processes include all stages in the development of a product, system, or process. Although the design process may have distinctive stages, they are not followed in a rigid, step-by-step sequence. For example, students must evaluate their work at each stage of the process. As they do so, they may discover that they need to return to an earlier stage to make modifications or to complete a particular step sooner than was originally planned. A portfolio and/or design report is used to document the design process.

Appendix One is adapted from the work of Dr. Ann Marie Hill, Queen's University and The Ministry of Education and Training. (1995). *Broad-based Technological Education.* Grades 10, 11, and 12, pp. 8-10.

Appendix 2: A Sample Design Process

Open-ended Problem Solving and the Design Process

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

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

Design processes vary within and across the different technological education areas. One example of a design process for manufacturing technology for Grades 9 and 10 levels is described below:

1. Identification and Clarification of a Technological Problem

Students identify the technological problem and begin keeping a record of the design process. Initially, students should outline the broad aims of the project and describe in a general way what needs to be done to achieve those aims. As work progresses on the project, students may periodically revise the initial broad plan to reflect what is actually happening.

In Grade 9, the teacher designates this stage when the teacher implements a given activity in this course profile. Students need to translate the information given to them by the teacher into the sub-stages below. This provides an understanding of each sub-stage so that they can independently complete the stage in later grades. Possible sub-stages for the portfolio and/or design report are:

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

2. Generation of Multiple Solutions

Students identify possible solutions for the technological problem and the resources required to achieve each proposed solution. They determine whether the required resources are available and record their findings. During this stage students may discover that they need to redefine the problem. Possible sub-stages for the portfolio and/or design report include:

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

Appendix 2: A Sample Design Process (Continued)

3. Selection of a Best Solution

Students establish evaluation criteria for the selection of a best solution. They consider such factors as: what materials, tool, and resources are available; the amount of time needed to carry out difficult procedures; and any relevant ergonomic and aesthetic requirements. Based on the results of these activities, they choose the best solution. They record the reasons for choosing a particular solution. Possible sub-stages for the portfolio and/or design report include:

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

4. Production Plan

Students determine ways of producing the best solution and then construct a prototype of the product. They produce a full-sized prototype using production-type materials. They first draft a revised or working drawing. They then develop a production plan. As students move through the production phase, they may modify their best solution to incorporate ideas that emerge during construction. Students document all such changes. Possible sub-stages for the portfolio and/or design report include:

- creating three-view drawings of the selected idea--front, top, and right side;
- calculating the materials needed to produce the selected idea for the selected technological project, and the associated costs;
- ordering of supplies for the selected technological project;
- development of a production flow chart that includes group member duties and manufacturing schedules for the selected technological project, using a Gantt Chart, Critical Path Network, or other types of flow charts;
- producing the product and document, in detail, the sequential steps used, and all modifications made, to produce the technological project.

5. Project and Process Evaluation

Students evaluate the product and process used for their technological project. They consider their own expectations and criteria and the reactions of their peers, teachers, and if applicable, their client. As a result of their evaluation or testing, they may decide to modify the production process, the product, or even the original definition of the problem. Students record all of the suggested changes. Possible sub-stages for the portfolio and/or design report include:

- testing the technological project and record the results;
- reflection on the process used to produce the technological project;
- describing required changes for an improved process and product revision.

6. Present the Results

The final product and the final portfolio and/or design report are presented to communicate the results.

Appendix 2 is adapted from the work of Dr. Ann Marie Hill, Queen's University

Appendix 3: Glossary of Electronic Terms

IC (**integrated circuit**) is a specialized self-contained circuit with several components and/or circuits designed to perform a particular function (computer chip).

OHM is a unit of resistance.

Resistor limits current flow.

Capacitor is a device that stores a charge.

MFD is **micro farad**, or the unit used to describe the amount of electrical energy a capacitor can hold.

Light-emitting diodes (**LED**) is a device that allows current to flow in one direction, when current flows through it emits light (low resistance).

Digital Electronics is based on the binary system and has on/off signals only.

Analog Electronics is based on the decimal system where signals are transmitted at different levels.

Alternating Current (**AC**), current flows in two directions (e.g., household current)

Direct Current (**DC**), electrical current flowing in one direction (e.g., battery)

Cathode is the negative side of a diode.

Anode is positive side of a diode.

VDC is an acronym for the voltage applied as direct current.