TECHNOLOGY EDUCATION 11 AND 12

Industrial Design

Integrated Resource Package 1997

BRITISH COLUMBIA
Ministry of Education, Skills and Training

IRP 076

PREFACE: USING THIS INTEGRATED RESOURCE PACKAGE

INTRODUCTION TO TECHNOLOGY EDUCATION 11 AND 12

THE INDUSTRIAL DESIGN 11 AND 12 CURRICULUM

TECHNOLOGY EDUCATION 11 AND 12 APPENDICES

This Integrated Resource Package (IRP) provides some of the basic information that teachers require to implement the Technology 11 and 12 curriculum. The information contained in this IRP is also available through the Internet. Contact the Curriculum and Resources Branch home page: http://www.est.gov.bc.ca/curriculum/welcome.htm

THE INTRODUCTION

The Introduction provides general information about Technology Education 11 and 12, including special features and requirements. It also provides a rationale for the teaching of Technology Education 11 and 12 in BC schools.

THE INDUSTRIAL DESIGN 11 AND 12 CURRICULUM

The main body of this document consists of the Industrial Design 11 and 12 courses of the Technology Education 11 and 12 curriculum. When additional Technology Education 11 and 12 courses are completed, they will be added to this IRP.

The Industrial Design 11 and 12 curriculum is structured in terms of curriculum organizers. There are four columns of information for each organizer in the Industrial Design 11 and 12 curriculum. These columns describe:

- provincially prescribed learning outcome statements for each subject area
- suggested instructional strategies for achieving the outcomes
- suggested assessment strategies for determining how well students are achieving the outcomes
- provincially recommended learning resources

Prescribed Learning Outcomes

Learning outcome statements are content standards for the provincial education system. Prescribed learning outcomes set out the knowledge, enduring ideas, issues, concepts, skills, and attitudes for each subject. They are statements of what students are expected to know and be able to do in each grade. Learning outcomes are clearly stated and expressed in observable terms. All learning outcomes complete this stem: "It is expected that students will. . . ." Outcome statements have been written to enable teachers to use their experience and professional judgment when planning and evaluating. The outcomes are benchmarks that will permit the use of criterion-referenced performance standards. It is expected that actual student performance will vary. Evaluation, reporting, and student placement with respect to these outcomes depend on the professional judgment of teachers, guided by provincial policy.

Suggested Instructional Strategies

Instruction involves the use of techniques, activities, and methods that can be employed to meet diverse student needs and to deliver the prescribed curriculum. Teachers are free to adapt the suggested instructional strategies or substitute others that will enable their students to achieve the prescribed outcomes. These strategies have been developed by specialist and generalist teachers to assist their colleagues; they are suggestions only.

Suggested Assessment Strategies

The assessment strategies suggest a variety of ways to gather information about student performance. Some assessment strategies relate to specific activities; others are general. These strategies have been developed by specialist and generalist teachers to assist their colleagues; they are suggestions only.

Provincially Recommended Learning Resources

Provincially recommended learning resources are materials that have been reviewed and evaluated by BC educators in collaboration with the Ministry of Education, Skills and Training according to a stringent set of criteria. They are typically materials suitable for student use, but they may also include information primarily intended for teachers. Teachers and school districts are encouraged to select those resources that they find most relevant and useful for their students, and to supplement these with locally approved materials and resources to meet specific local needs. The *recommended* resources listed in the main body of this IRP are those that have a comprehensive coverage of significant portions of the curriculum, or those that provide a unique support to a specific segment of the curriculum. Appendix B contains a complete listing of provincially recommended learning resources to support this curriculum.

THE APPENDICES

A series of appendices provides additional information about the curriculum and further support for the teacher.

- ***Appendix A*** lists the prescribed learning outcomes for the curriculum arranged by curriculum organizer and grade.
- ***Appendix B*** contains a comprehensive, annotated list of the provincially recommended learning resources for this curriculum. This appendix will be updated as new resources are evaluated.
- ***Appendix C*** outlines the cross-curricular reviews used to ensure that concerns such as equity, access, and the inclusion of specific topics are addressed by all components of this IRP.
- ***Appendix D*** contains assistance for teachers related to provincial evaluation and reporting policy. Prescribed learning outcomes have been used as the source for samples of criterion-referenced evaluation.
- ***Appendix E*** acknowledges the many people and organizations that have been involved in the development of this IRP.

Grade

Curriculum Organizer and Suborganizer

GRADE 11 • *Design and Communication (Principles and Concepts of Technology)*

Prescribed Learning Outcomes

The Prescribed Learning Outcomes column of this IRP lists the specific learning outcomes for each curriculum organizer or suborganizer.

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- describe aesthetic and functional purposes for design elements (line, shape, form, colour, texture) in product and system designs
- describe how product and system designs are influenced by specifications such as:
  - industry standards
  - function
  - availability of resources
  - user requirements
- evaluate the effect of a variety of processes, tools, and techniques used to plan, research, and communicate design information and production details
- describe the effect of technological change on postsecondary and career opportunities in the field of design and production

SUGGESTED INSTRUCTIONAL STRATEGIES

Students learn to solve design problems and communicate design ideas by examining past and present product designs. As they learn about the elements of design and apply knowledge and skills from other disciplines, they enhance their understanding of the elements of design.

- Discuss with students design processes used to develop an existing sport or recreational product. (e.g., Present the class with three brands of skateboard, including past and current models.) Have them record information on the development of the design, including variations in design elements, structure, and materials (e.g., wood versus composite). Ask students to discuss how these variations relate to function and aesthetics.
- Provide students with an illustration that describes the design process. Have them keep journals in their portfolios to record their own design experiences from specific projects and to reflect on the design process.
- Form teams, and ask each team to select a product (e.g., telephone, fax machine) and then research the development of the product design. Challenge each team to use a variety of resources (e.g., on-line searches, electronic forums, community sources) to gather information about the historical development of the product design, the impact of specifications on the product design, technological developments, ergonomics, engineering principles, and aesthetics. Encourage them to select various communication tools to present their findings to the class.
- Have students investigate careers and occupations related to design and communication (e.g., through guest speakers, work experience, job shadowing, career preparation options) and determine the educational prerequisites. Ask each to select a career and develop a classified ad for a company seeking to employ a qualified, experienced person to fill the job.

Suggested Instructional Strategies

The Suggested Instructional Strategies column of this IRP suggests a variety of instructional approaches that include group work, problem solving, and the use of technology. Teachers should consider these as examples that they might modify to suit the developmental levels of their students.

Grade

Curriculum Organizer and Suborganizer

GRADE 11 • *Design and Communication (Principles and Concepts of Technology)*

Suggested Assessment Strategies

The Suggested Assessment Strategies offer a wide range of different assessment approaches useful in evaluating the prescribed learning outcomes. Teachers should consider these as examples they might modify to suit their own needs and the instructional goals.

SUGGESTED ASSESSMENT STRATEGIES

As students analyse the design elements of past and present products, they can demonstrate their understanding of the aesthetic and functional value of these elements.

- Present students with examples of processes and practices used in the design of a particular product (e.g., skis, bicycles) that has changed over time. To help students evaluate the changes, pose questions such as:
  - How has the structural design improved? Has the safety of the product improved as a result?
  - What are the advantages of using the current materials in the product as compared to those previously used? Are there any negative environmental issues related to these materials?
  - How have the aesthetics changed, and what impact have these changes had on the visual appeal of the product?
- Work with students to develop criteria that will be used to assess their research presentations on the development of a product design. Criteria might include:
  - use of a variety of relevant sources of information
  - accuracy of information
  - use of correct terminology
  - effective presentation of information
  - identification of impact of specifications on the design process
- Have students conduct hands-on research to compare and contrast a variety of manual and electronic drawing techniques and communication methods while working in "companies" that design, develop, and market products. As the teams demonstrate their findings to the class, note their abilities to:
  - identify the strengths and limitations of the various drawing techniques
  - clearly communicate their ideas using various communication methods (e.g., multimedia, flow charts)
  - clearly delineate the levels of responsibility for specific tasks related to the design, development, and communications of ideas
  - work collaboratively in their "companies"

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Design Graphics
- Electrical/Electronic Systems
- Energy
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology at Work
- Industrial Design
- Inside Combustible Engines
- Land Transportation
- The New Digital Imaging
- Sea Transportation
- Technology for the Disabled

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Welcome to...Macintosh Multimedia
- Welcome to...PC Sound, Music, and MIDI

Recommended Learning Resources

The Recommended Learning Resources component of this IRP is a compilation of provincially recommended resources that support the prescribed learning outcomes. A complete list including a short description of the resource, its media type, and distributor is included in Appendix B of this IRP.

This Integrated Resource Package (IRP) sets out the provincially prescribed curriculum for Technology Education 11 and 12. This IRP currently includes the curriculum for Industrial Design 11 and 12. The following additional areas are among those under consideration for development as Technology Education 11 and 12 courses:

- Production and Manufacturing Technology
- Construction Technology
- Systems Technology
- Design and Communication Technology
- Biotechnology
- Transportation Technology

The development of this IRP has been guided by the principles of learning:

- Learning requires the active participation of the student.
- People learn in a variety of ways and at different rates.
- Learning is both an individual and a group process.

RATIONALE

Technology is embodied in devices that extend human capabilities. It provides the tools to extend our vision, to send and receive sounds and images from around the world, and to improve health, lifestyle, economies, and ecosystems. As technology assumes an increasingly dominant force in society, technological literacy is becoming as essential as numeracy skills and the ability to read and write. In providing the fundamentals of technological literacy, technology education helps young people prepare to live and work in a world of continuously evolving technologies.

Preparing the Citizen

A technologically literate person uses tools, materials, systems, and processes in an informed, ethical, and responsible way. To be responsible members of society, students must be aware of the impact that ever-changing technology has on their lives. They need to reflect critically on technology's role in society and consider its positive and negative effects. Technology education fosters the development of skills and attitudes that increase students' abilities to responsibly address the social and ethical issues of technological advancements.

Preparing for the Workplace

To meet career challenges, students must be able to communicate effectively, make independent decisions, solve problems, work independently and co-operatively with individuals from diverse backgrounds, and become technically competent. In Technology Education 11 and 12 courses students have the opportunity to develop a variety of skills and abilities essential for employment in today's economy.

Activities in Technology Education provide opportunities for students to develop, reinforce, and apply:

- numeracy skills as they calculate, estimate, and measure
- information skills as they identify, locate, gather, store, retrieve, process, and present information
- communication skills as they apply technology to communicate their design ideas, solutions, reflections, and products
- problem-solving skills as they identify, describe, and analyse problems, and test their ideas and solutions

- social and co-operative skills as they interact with others to solve problems and complete projects
- leadership and project-management skills as they set goals, plan, address challenges, and resolve conflicts
- physical skills as they carry out technological tasks using tools, equipment, and materials correctly, efficiently, and safely

These senior courses build on and extend the Technology Education curriculum developed for students in earlier grades. This IRP provides students in Grades 11 and 12 with the skills and knowledge needed to pursue studies toward careers as technicians, technologists, engineers, architects, industrial designers, and various trades, or to enter directly into the work force.

Technology Education Kindergarten to Grade 12 Objectives

The aim of the Technology Education curriculum is to help students develop technological literacy and lifelong learning patterns that they need to live and work effectively in a changing technological society. To achieve this, the curriculum provides a framework for students to learn how to design and construct solutions to real-world problems and opportunities to put into practice what they have learned.

The Technology Education curriculum is guided by the following curriculum intentions. Technology Education provides students with opportunities to:

- develop the ability to solve technological problems
- develop the ability to make things and explore technology
- develop the ability to deal ethically with technology
- develop lifelong learning patterns needed to function effectively in a changing technological environment
- acquire skills and attitudes needed to work with technology both independently and as a co-operative member of a group
- develop appropriate attitudes and practices with respect to work safety and personal health
- gain competence in working with tools, materials, and processes to produce high-quality work
- develop language and visual communication skills to investigate, explain, and illustrate aspects of technology
- apply and integrate skills, knowledge, and resources across disciplines and in technological activities
- explore and pursue technological careers and associated lifestyles
- become discerning users of materials, products, and technical services

The Technology Education Kindergarten to Grade 12 chart provides an overview of the Technology Education curriculum.

Technology Education K to 12

▼ Grades K to 3 Students begin to appreciate that technology is everywhere. They become aware of the role of technology in their lives by exploring familiar devices. Through problem-solving activities, they develop group interaction and communication skills, and self-confidence in handling simple processes and products. Student activities are based on classroom themes and their own experiences and personal interests.	***In grades K to 3, students:*** • construct devices that are useful and relevant to them • explore materials, tools, and processes, independently and in groups • realize that there are several solutions to a single problem • learn the importance of using tools and materials safely
▼ Grades 4 to 7 Students consider the personal, community, and global consequences of the use of technology now and in the future, and develop a concern for its responsible application. They investigate the historical development of technology and begin to appreciate its impact on society and individuals. By investigating a product from its inception to its completion, students learn to research, create, and communicate solutions to design problems.	***In grades 4 to 7, students:*** • gain experience using a variety of communication tools (e.g., modem, CD-ROM, video, overhead projector) • identify problems involving design and investigate possible solutions • use an expanding variety of tools, materials, and production processes • use objective tests and feedback to refine and modify designs • become increasingly responsible for managing their time and resources, and for planning and organizing their activities within a specific task • begin to recognize that a system is made up of parts and devices that interact to achieve a purpose
▼ Grades 8 to 10 Students work in specialized environments to develop technological solutions to problems that they identify or that are identified for them. They continue to learn about the technical requirements of various careers. They consider the personal, local, and global consequences, and the cultural, ethical, and aesthetic implications of technology. They investigate the future applications of technology to improve the human condition.	***In grades 8 to 10, students:*** • set goals, develop plans, and assess their own abilities to design products (individually and in groups) • use graphic designs and oral and written language to convey technical ideas • learn about the safe use of specialized tools and machinery • consider how they will use technology in daily life and in the workplace • study the characteristics and uses of materials and information while solving problems involving designs that occur in daily life and in the workplace • learn to create and manage systems that energize and control products
▼ Grades 11 and 12 Students work in a sophisticated technological learning environment designed to promote their skills, knowledge, and abilities to solve complex and varied problems. Students take advantage of opportunities to prepare for postsecondary training opportunities.	***In grades 11 and 12, students:*** • develop skills appropriate to the workplace • produce products and systems that meet community standards • work in co-operative groups to develop solutions to real-life problems • develop detailed understanding of materials, processes, systems, and information gathering • select appropriate technologies to solve problems • evaluate possible solutions using models, simulations, and prototypes

CURRICULUM ORGANIZERS

There are two types of curriculum organizers in Technology Education 11 and 12 courses. Content-related organizers form the basic framework for the course, and process-based suborganizers further define outcomes within each organizer.

For descriptions of the organizers and suborganizers, see the Course Description at the beginning of the Curriculum section of this IRP.

SUGGESTED INSTRUCTIONAL STRATEGIES

Instructional strategies have been included for each curriculum organizer and grade level. These strategies are suggestions only, designed to provide guidance for generalist and specialist teachers planning instruction to meet the prescribed learning outcomes. The strategies may be either teacher directed or student directed, or both. For each organizer, a list of specific strategies is introduced by a context statement that focusses the reader on the important aspects of this section of the curriculum and links the prescribed learning outcomes with instruction.

There is not necessarily a one-to-one relationship between learning outcomes and instructional strategies, nor is this organization intended to prescribe a linear means of course delivery. It is expected that teachers will adapt, modify, combine, and organize instructional strategies to meet the needs of students and to respond to local requirements.

Strategies

The suggested instructional strategies may be undertaken by individual students, partners, or small groups. Technology Education 11 and 12 emphasizes skills needed in a changing society. As a result, emphasis is given to the following strategies.

- *Strategies that develop applied skills.*
  In order to see technology education as relevant and useful, students must learn how it can be applied to a variety of real-world situations. Technology education helps students to understand and interpret their world, and to identify and solve problems that occur in their daily lives and in the workplace.
- *Strategies that foster the development of individual and group skills.*
  In the workplace, people need to know how to work effectively, individually and with others, to solve problems and complete tasks. Students need opportunities to work independently to enhance their organizational and self-evaluation skills. Students also need to experience the dynamics of group work to enhance their understanding of group problem-solving processes. Group work focusses on such skills as collaboration, communication, leadership, and co-operation.
- *Strategies that foster research and critical-thinking skills.*
  In order to make informed and responsible choices about the appropriate use of technology, students need to receive and process information critically.
- *Strategies that use technology.*
  The ability to use technology to solve problems is a necessary skill in the workplace and an important “new basic” in postsecondary education. Students use technology to access information, to calculate, and to enhance the presentation of ideas.

- *Strategies that require solving design and production problems.*
  Students identify needs, pose real or invented problems of their own, and respond to problems presented by the teacher.

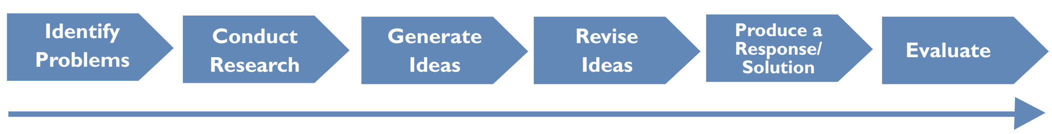
Problem-Solving Models

To develop decision-making and problem-solving skills, students need to be challenged to identify problems and develop solutions. The problems students identify or are assigned in technology education involve improving existing products and systems, as well as designing and developing new ones.

Models that describe problem-solving processes should be developed with students so they understand the recurring nature of solving real-world problems (as part of a problem is solved, new problems arise and some steps in the processes recur). The following diagrams present a variety of approaches to describe problem solving in technology education. They are intended to provide teachers with ideas; they are not prescribed models.

A Simple Linear Model

Some models suggest that problem solving is a set of clearly defined and prescribed steps. This is rarely the case.

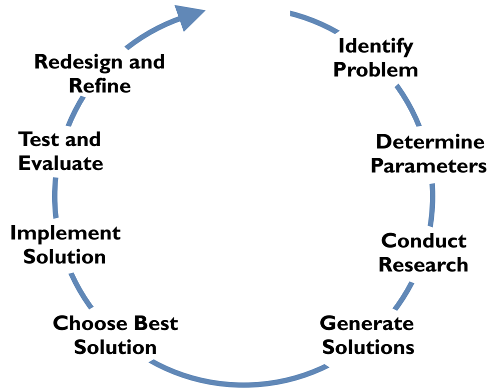


Designing, Troubleshooting, and Social Impact Models

Some specialized problems are approached in unique ways.

Designing

Designing is a problem-solving method used to develop solutions leading to the creation of articles, systems, or environments.



Troubleshooting

Troubleshooting is a method of solving problems used to isolate and diagnose a malfunction.

- Identify purpose of system (inputs and outputs)
- Identify purpose of subsystems (inputs and outputs)
- Test subsystems
- Identify cause and implement solution
- Test solution

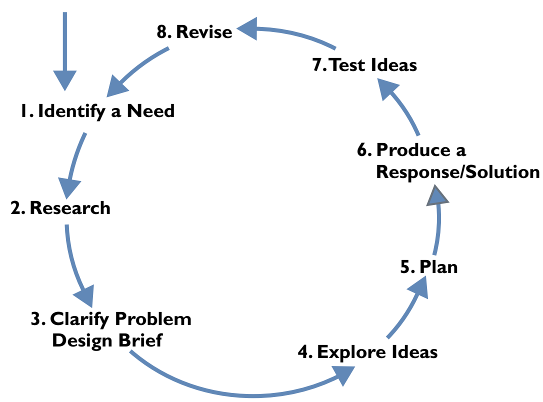
Social Impact

This is a method of solving problems used to appraise the social, environmental, and ethical implications of technological decisions.

- Identify consequences and effects
- Develop a value system through critical thinking
- Judge benefits and disadvantages of technological applications
- Make ethical decisions

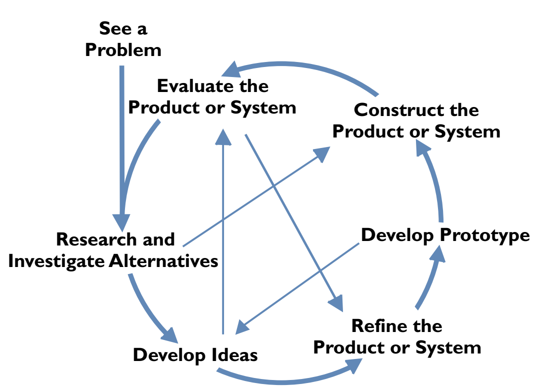
Action Model

Some models suggest a continuous flow of activity, from problem identification to the development of a refined product.

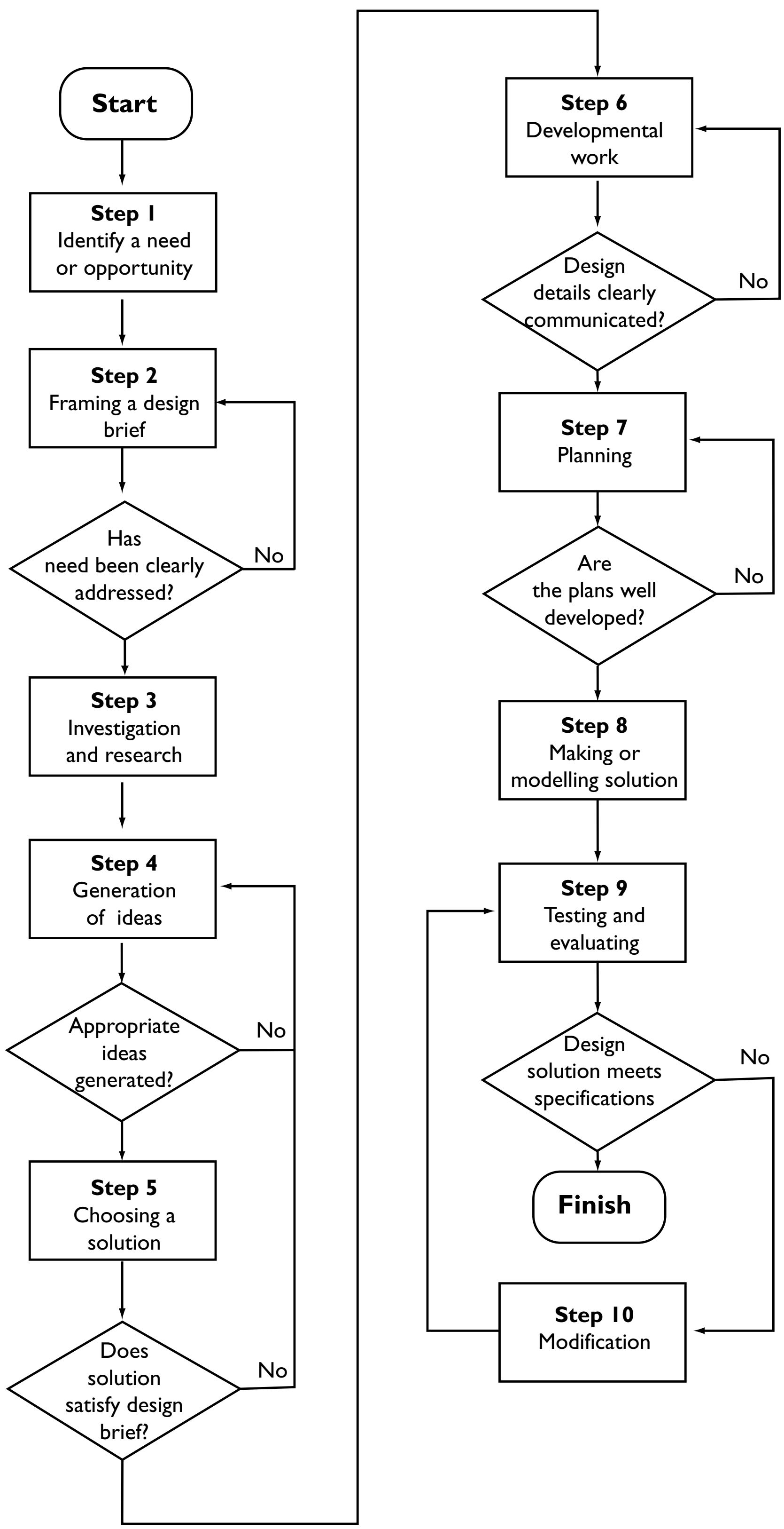


Interactive Model

Interactive models illustrate the complexity of a process, in which at any time you might move to any point in the process in order to figure something out.



Design Loop Model



Suggested Assessment Strategies

The assessment strategies in this IRP describe a variety of ideas and methods for gathering evidence of student performance, and provide examples of criteria for assessing the extent to which the prescribed learning outcomes have been met. Teachers determine the best assessment methods for gathering this information.

For each organizer, a list of specific strategies is introduced by a context statement that explains how students at this age can demonstrate their learning, what teachers can look for, and how this information can be used to plan further instruction.

The assessment strategies or criteria examples for a particular organizer are always specific to that organizer. Some strategies relate to particular activities, while others are general and could apply to any activity.

About Assessment in General

Assessment is the systematic process of gathering information about students' learning in order to describe what they know, are able to do, and are working toward. From the evidence and information collected in assessments, teachers describe each student's learning and performance. They use this information to provide students with ongoing feedback, plan further instructional and learning activities, set subsequent learning goals, and determine areas for further instruction and intervention. Teachers determine the purpose, aspects, or attributes of learning on which to focus the assessment. They also decide when to collect the evidence and which assessment methods, tools, or techniques are most appropriate.

Assessment focusses on the critical or significant aspects of the learning that students will be asked to demonstrate. Students benefit when they clearly understand the learning goals and learning expectations.

Evaluation involves interpreting assessment information in order to make further decisions (e.g., set student goals, make curricular decisions, plan instruction). Student performance is evaluated from the information collected through assessment activities. Teachers use their insight, knowledge about learning, and experience with students, along with the specific criteria they establish, to make judgments about student performance in relation to learning outcomes.

Students benefit when evaluation is provided on a regular, ongoing basis. When evaluation is seen as an opportunity to promote learning rather than as a final judgment, it shows learners their strengths and suggests how they can develop further. Students can use this information to redirect efforts, make plans, and establish future learning goals.

The assessment of student performance is based on a wide variety of methods and tools, ranging from portfolio assessment to pencil-and-paper tests. Appendix D includes a more detailed discussion of assessment and evaluation.

About the Provincial Learning Assessment Program

The Provincial Learning Assessment Program gathers information on students' performance throughout the province. Results from these assessments are used in the development and revision of curricula, and provide information about teaching and learning in British Columbia. Where appropriate, knowledge gained from these assessments has influenced the assessment strategies suggested in this IRP.

Provincial Reference Sets

The provincial reference sets can also help teachers assess the skills that students acquire across curricular areas. These are:

- *Evaluating Reading Across Curriculum* (RB 0034)
- *Evaluating Writing Across Curriculum* (RB 0020 & RB 0021)
- *Evaluating Problem Solving Across Curriculum* (RB 0053)
- *Evaluating Group Communication Skills Across Curriculum* (RB 0051)
- *Evaluating Mathematical Development Across Curriculum* (RB 0052)

A series of assessment handbooks developed to provide guidance for teachers as they explore and expand their assessment repertoires is also available:

- *Performance Assessment* (XX0246)
- *Portfolio Assessment* (XX0247)
- *Student-Centred Conferencing* (XX0248)
- *Student Self-Assessment* (XX0249)

Integration of Cross-Curricular Interests

Throughout the curriculum development and revision process, the development team has done its best to ensure that relevance, equity, and accessibility issues are addressed in this IRP. These issues have been integrated into the learning outcomes, suggested instructional strategies, and assessment strategies in this IRP with respect to the following:

- Applied Focus in Curriculum
- Career Development
- English as a Second Language (ESL)
- Environment and Sustainability
- Aboriginal Studies
- Gender Equity
- Information Technology
- Media Education
- Multiculturalism and Anti-Racism
- Science-Technology-Society
- Special Needs

(See Appendix C, Cross-Curricular Interests, for more information.)

Learning Resources

The Ministry of Education, Skills and Training promotes the establishment of a resource-rich learning environment through the evaluation of educationally appropriate materials intended for use by teachers and students. The media formats include, but are not limited to, materials in print, video, and software, as well as combinations of these formats. Resources that support provincial curricula are identified through an evaluation process that is carried out by practising teachers. It is expected that classroom teachers will select resources from those that meet the provincial criteria and that suit their particular pedagogical needs and audiences. Teachers who wish to use non-provincially recommended resources to meet specific local needs must have these resources evaluated through a local district approval process.

The use of learning resources involves the teacher as a facilitator of learning. However, students may be expected to have some choice in materials for specific purposes, such as independent reading or research. Teachers are encouraged to use a variety of resources to support learning outcomes at any particular level. A multimedia approach is also encouraged.

Some selected resources have been identified to support cross-curricular focus areas. The ministry also considers special-needs audiences in the evaluation and annotation of learning resources. As well, special-format versions of some selected resources (braille and taped-book formats) are available.

Learning resources for use in BC schools fall into one of two categories: *provincially recommended materials* or *locally evaluated materials.*

All learning resources used in schools must have *recommended* designation or be approved through district evaluation and approval policies.

Provincially Recommended Materials

Materials evaluated through the provincial evaluation process and approved through Minister's Order are categorized as *recommended* materials. These resources are listed in Appendix B of each IRP.

Locally Evaluated Materials

Learning resources may be approved for use according to district policies, which provide for local evaluation and selection procedures.

Internet Resources

Some teachers have found that the Internet (World Wide Web) is a useful source of learning resources. None of the material from this source has been evaluated by the ministry, in part because of the dynamic nature of the medium.

CONSIDERATIONS FOR INSTRUCTION IN TECHNOLOGY EDUCATION

When selecting and developing learning activities, consideration must be given to safety, gender equity, and diverse student needs.

Safety

Correct safety practices must be established as soon as students begin their studies in technology education and must be maintained throughout the curriculum. It is the responsibility of the teacher to ensure that students are aware of the hazards in facilities and that established safety procedures are followed. Teachers must use good judgment when instructing students in safety practices, remembering that the main objective is student learning.

It is essential that teachers address the following questions before, during, and after an activity:

- Has the instruction been sequenced progressively to ensure safety?
- Have students been given specific instruction about how to use and handle equipment and tools correctly?
- Are the tools and equipment in good repair, suitably arranged, and appropriately sized for students?
- Are students being properly supervised?
- Do the facilities provide adequate lighting and ventilation for the activity?
- Have students been made aware of hazards in the facility area?
- Have students been made aware of appropriate school-based and industrial safety standards?

Teachers should select safe activities, techniques, and projects and ensure that the safety practices are implemented. The following is not an all-inclusive list, but a guide to help teachers establish a safe learning environment. Students should:

- wear appropriate attire
- follow established rules and routines
- select tasks that are within their abilities
- demonstrate self-control and show respect for the safety of others
- recognize hazards in work areas

Gender Equity

The education system is committed to helping all students succeed. This is particularly important in the area of technology education, where female participation is low. Teaching, assessment materials, learning activities, and classroom environments should place value on the experiences and contributions of all people and cultivate interest and access for female students.

Teachers should consider the diversity of learning styles and watch for gender bias in learning resources, and bias in interaction with students. The following instructional strategies for technology education are provided to help teachers deliver gender-sensitive programs.

- Think of ways to feature women who make extensive use of technology in their careers—perhaps as guest speakers or subjects of study in the classroom.
- Develop instruction to acknowledge differences in experiences and interests between young women and young men.
- Demonstrate the relevance of technology education to careers and to daily life in ways that appeal to a variety of students in the class or school. Successful links include biology, environmental issues, architecture and design, computers, and current affairs.
- Explore ways of teaching the uses of design and technology that will appeal to a broader range of students.
- Provide practical learning opportunities designed specifically to help young women develop confidence and interest in technology education and non-traditional roles.
- Emphasize that technology is used by people with various interests and responsibilities.
- Provide opportunities for visual and hands-on activities. Experiments, demonstrations, field trips, and exercises that provide opportunities to explore the relevance of technology education are important for both young women and young men.

Diverse Student Needs

Students with special needs are those with intellectual, physical, sensory, learning, behavioural, and other emotional disabilities, or students who are gifted or talented. Opportunities for success are enhanced for all students when instruction and assessment methods are adapted to meet a wide range of students' educational needs, learning styles, and modes of expression.

Technology education, particularly activity-based technology education, has traditionally been a significant area for pre-employment skill-development opportunities and an ideal area for students with special needs. Technology education, with its focus on the benefits of concrete, real-world experiences, provides students with opportunities to work effectively in group situations, focussing on observation and experimentation, and alternative methods of evaluation. For students with exceptional gifts or talents, this curriculum area is also ideal for creative learning experiences and critical-thinking activities. Opportunities for extension and acceleration are rich in technology education, and, for some students with special needs, this curriculum can provide opportunities to apply personal experiences to enrich their learning.

When students with special needs are expected to achieve or surpass the learning outcomes set out in the Technology Education 11 and 12 curriculum, regular grading practices and reporting procedures are followed. However, when students are not expected to achieve the learning outcomes, modifications must be noted in their Individual Education Plans (IEPs). When students require adaptations in order to meet the regular learning outcomes, these too should be noted in an IEP. The following strategies may help students with special needs succeed in technology education.

- *Adapt the Environment*
  - cluster-group students with particular gifts or needs
  - make use of preferential seating to enhance learning
  - create a space with minimum distractions
  - change the location of the learning activity to optimize concentration
  - make use of co-operative grouping or pairing of learners
- *Adapt Presentation or Instruction*
  - make extensions of activities for students with special gifts and talents
  - offer choices for self-directed learning
  - provide advance organizers of key technology education concepts
  - demonstrate or model new concepts
  - adjust the pace of activities as required
  - change the wording of questions or instruction to match the student's level of understanding
  - provide functional, practical opportunities for students to practise skills
  - use bilingual peers or volunteers to help ESL students (e.g., clarify safety rules)
- *Adapt Materials and Equipment*
  - use techniques to make the organization of activities more explicit (e.g., colour-code the steps used to solve a problem)
  - use manipulatives
  - provide large-print charts or activity sheets
  - use opaque overlays to reduce the quantity of visible print
  - highlight key points in written material
  - provide software that defaults to a larger font size
  - use adapted computer technology hardware and appropriate software
  - provide alternative resources on the same concepts at an easier comprehension level
  - use translated material for information (e.g., safety rules)
  - provide or arrange opportunities for independent research (e.g., CD-ROM)
- *Adapt Methods of Assistance*
  - train and use peer tutors to assist students with special needs
  - arrange for teacher assistants to work with individuals or small groups
  - collaborate with support teachers to develop appropriate strategies for individual students with special needs
- *Adapt Methods of Assessment*
  - allow students to demonstrate their understanding of technology education concepts in a variety of ways (e.g., through murals, displays, models, oral presentations)
  - match assessment tools to students' needs (e.g., oral or open-book tests, tasks performed without time limits, teacher and student conferencing)
  - set short-term achievable goals with frequent feedback
  - provide opportunities for students to do self-assessment and individualized goal setting

Terms used in Technology Education

CAM	Computer-aided manufacturing; the operation of a machine controlled by a host computer.
CAD or CADD	Computer-aided design (and drafting): a precision-drawing software program that speeds up the design process by making it easier to create and modify draft designs.
design brief	A concise problem statement devalued by a student or teacher that identifies what the student will do and what the successful solution will achieve.
design portfolio	A record of the development of a project from inception to completion.
design principles	Qualities of balance, layout, measurement, colour, scale, and projection.
design process	A planning and decision-making process that produces a solution.
input	Data, materials, resources, or instructions entered into (most often) a computer system.
kinetic energy	The energy of a mass in motion (e.g., pendulum swinging, spring unwinding).
kinematics	The study of motion, without regard to the force of mass of things moving.
output	The actual results of a system, desired or undesired, expected or unexpected.
pneumatics	Using air or gas pressure to operate mechanical devices.
potential energy	The ability to do work using stored energy (e.g., compressed spring, charged capacitor, gasoline).
production	The process of converting and combining resources to construct, manufacture, or grow something.
robots	Programmable, multifunctional devices that perform physical tasks.
WHMIS	Workplace Hazardous Materials Information Systems; product safety information issued by the BC Workers' Compensation Board.

CURRICULUM

Industrial Design 11 and 12

Industrial Design 11 and 12 provides students with opportunities to:

- use technology to design and create products, systems, and environments that meet community needs
- apply concepts and principles of design, systems integration, and product development in hands-on activities
- create, invent, think critically, solve problems, and engage in teamwork
- select and use materials, tools, and equipment skilfully and safely

These learning experiences help students acquire some of the skills and knowledge needed to pursue postsecondary training for careers as technologists, technicians, architects, engineers, and industrial designers.

CURRICULUM ORGANIZERS

Four content-based curriculum organizers form the basic framework for the curriculum, and three process-based suborganizers further define each curriculum organizer.

The curriculum organizers are:

- Design and Communication
- Product Development
- Systems Integration
- Energy, Power, and Transportation

Design and Communication

Prescribed learning outcomes in Design and Communication focus on knowledge and skills students need to effectively develop and communicate design ideas. Students are given opportunities to use various communication processes, including:

- sketching
- technical drawing
- computer-assisted drafting and design (CADD)
- video and photography
- modelling
- animation and simulation
- developing multimedia presentations

Product Development

Prescribed learning outcomes in Product Development focus on knowledge and skills students need to design and make products and systems that meet specific design criteria and community standards. Students are given opportunities to use a variety of industry-based materials, tools, machines, and equipment, including CADD, computer-assisted manufacturing (CAM), and computer numeric control (CNC).

Systems Integration

Prescribed learning outcomes in Systems Integration focus on knowledge and skills related to the integration and management of technological systems. The emphasis is on digital technology, the backbone of virtually all modern technical systems, from home appliances to automated production systems. Students are given opportunities to design, construct, and use systems to control electrical, electronic, pneumatic, hydraulic, and mechanical systems and subsystems.

Energy, Power, and Transportation

Prescribed learning outcomes in Energy, Power, and Transportation provide students with opportunities to investigate the applications for and effects of using energy, power, and transportation. Students are asked to manipulate components of mechanical and electromechanical systems in order to convert, transmit, conserve, and use energy and power.

SUBORGANIZERS

The suborganizers for each organizer are:

- Principles and Concepts of Technology
- Problem Solving
- Modification and Manipulation

Principles and Concepts of Technology emphasizes:

- key principles and concepts related to the organizer
- applications and types of tools and materials used

Problem Solving emphasizes:

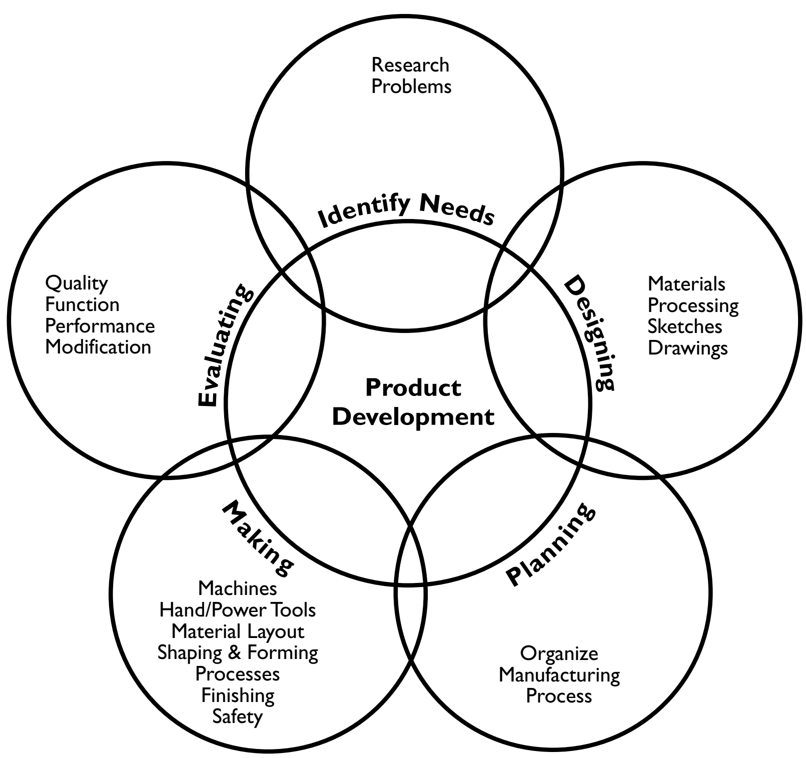
- working with others to identify and solve problems using skills such as analysis, troubleshooting, researching, diagnosing, and generating solutions
- developing solutions using specific criteria and prior knowledge
- communicating and assessing design solutions

Modification and Manipulation emphasizes:

- using processes, skills, and materials to design and create relevant products or systems to meet community standards
- using industry-based tools and materials safely and effectively

Together, the curriculum organizers and suborganizers provide a structure for the learning outcomes, leaving to the teacher's professional judgment how to combine the learning outcomes for instruction and assessment. To allow for the dynamic nature of learning, it is not intended that any one organizer be used in isolation or as a basis for a lesson or unit of instruction.

The Industrial Design 11 and 12 Overview chart provides further detail on the relationship between organizers and suborganizers.



Industrial Design 11 and 12 Overview

Organizers	Suborganizers		
	Principles and Concepts of Technology	**Problem Solving**	**Modification and Manipulation**
Design and Communication	Students learn principles and concepts related to design and communication, including standards and conventions and the elements of design. They explore career options in design and technology.	Students apply communication processes to solve design problems and build design portfolios. They develop individual and group skills in solving design problems.	Students use various processes, skills, and technologies to develop and communicate design ideas.
Product Development	Students learn about the effects of using different materials, processes, tools, and technologies in product manufacturing. They examine the impact of technological advances, manufacturing, and products on self and society, the end-user, and the environment.	Students apply critical-analysis skills to develop products that satisfy functional requirements and aesthetics. They interpret design specifications for a completed product—testing, evaluating, and redesigning when necessary.	Students use a variety of materials, processes, and tools to manufacture high-quality products that incorporate technical, functional, and aesthetic features. They apply safety practices set out by WHMIS and the WCB.
Systems Integration	Students learn about concepts such as input, process, output, and feedback in controlling systems. They learn how electronic systems integrate with electrical, pneumatic, hydraulic, and mechanical systems and subsystems.	Students solve systems integration problems and design systems that achieve functional results.	Students construct and modify systems using a range of materials, processes, and equipment. They investigate, analyse, and control the performance of a system based on the operation of each of its components.
Energy, Power, and Transportation	Students learn how performance is measured in a system that converts energy. They examine the environmental, social, and ethical implications of energy, power, and transportation systems on society, and they consider the development and implementation of alternative energy sources.	Students troubleshoot, diagnose problems, and document information related to energy, power, and transportation systems.	Students design and build systems that use energy and power. They manipulate pneumatic and hydraulic systems.

PLANNING AN INDUSTRIAL DESIGN 11 AND 12 PROGRAM

Teachers are encouraged to integrate a variety of topics and instructional approaches to develop Industrial Design 11 and 12 courses that address the prescribed learning outcomes; take advantage of the available resources and facilities; meet community needs; and take into account the different interests, learning styles, and abilities of learners.

The Framework for Developing Instructional Units chart provides examples of problems, projects, and themes that might be useful in planning units for Industrial Design 11 and 12.

Framework for Developing Instructional Units

Unit Approach	Sample Activities
Problem Solving *Problem solving* involves identifying problems related to daily life, investigating options, determining solutions, and establishing courses of action.	• Develop a device that assists a disabled person in gaining access to a building. • Illustrate how aerodynamics affect fuel efficiency and performance. • Design an efficient system that can convert energy to motion. • Design a parking lot that optimizes space and traffic flow. • Select design elements to create an aesthetic, ergonomic workstation.
Project A *project* involves the design and construction of a product or system to meet a need.	• Possible projects: - a barrier-free habitat for someone who is disabled - an efficient vehicle - a security system - an age-appropriate children's toy - a lightweight tent or backpack
Theme A *theme* is a common idea or feature that unifies a study.	• Video Production (sound mixing, editing, commercial production) • Space Exploration (robotic arm, propulsion) • Environment (climate control, waste management) • Marine (floating home, catamaran, safety devices) • Aircraft (wing design, control systems)

Facilities

Industrial Design 11 and 12 is a significant shift from Industrial Education. Schools might need to modify their existing facilities to enable students to achieve the prescribed learning outcomes in the new curriculum. Existing space might be divided into separate areas for: planning and problem solving, design, material preparation and modification, and product and materials storage. If there is no available design or computer space in the existing production area, it might be possible to share other spaces in the school.

Equipment and Tools

Industrial Design 11 and 12 requires that students have access to and experiences with a variety of tools and equipment. This might include:

- computer systems that support design and production (CADD, CAM, CNC)
- computer peripherals
- software
- multimedia equipment
- stationary equipment and hand tools
- testing and diagnostic equipment

Graduation Requirements

Industrial Design 11 and Industrial Design 12 are two of the provincially approved courses that satisfy the two-credit applied skills requirement for graduation.

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- describe aesthetic and functional purposes for design elements (line, shape, form, colour, texture) in product and system designs
- describe how product and system designs are influenced by specifications such as:
  - industry standards
  - function
  - availability of resources
  - user requirements
- evaluate the effect of a variety of processes, tools, and techniques used to plan, research, and communicate design information and production details
- describe the effect of technological change on postsecondary and career opportunities in the field of design and production

SUGGESTED INSTRUCTIONAL STRATEGIES

Students learn to solve design problems and communicate design ideas by examining past and present product designs. As they learn about the elements of design and apply knowledge and skills from other disciplines, they enhance their understanding of the elements of design.

- Discuss with students design processes used to develop an existing sport or recreational product. (e.g., Present the class with three brands of skateboard, including past and current models.) Have them record information on the development of the design, including variations in design elements, structure, and materials (e.g., wood versus composite). Ask students to discuss how these variations relate to function and aesthetics.
- Provide students with an illustration that describes the design process. Have them keep journals in their portfolios to record their own design experiences from specific projects and to reflect on the design process.
- Form teams, and ask each team to select a product (e.g., telephone, fax machine) and then research the development of the product design. Challenge each team to use a variety of resources (e.g., on-line searches, electronic forums, community sources) to gather information about the historical development of the product design, the impact of specifications on the product design, technological developments, ergonomics, engineering principles, and aesthetics. Encourage them to select various communication tools to present their findings to the class.
- Have students investigate careers and occupations related to design and communication (e.g., through guest speakers, work experience, job shadowing, career preparation options) and determine the educational prerequisites. Ask each to select a career and develop a classified ad for a company seeking to employ a qualified, experienced person to fill the job.

SUGGESTED ASSESSMENT STRATEGIES

As students analyse the design elements of past and present products, they can demonstrate their understanding of the aesthetic and functional value of these elements.

- Present students with examples of processes and practices used in the design of a particular product (e.g., skis, bicycles) that has changed over time. To help students evaluate the changes, pose questions such as:
  - How has the structural design improved? Has the safety of the product improved as a result?
  - What are the advantages of using the current materials in the product as compared to those previously used? Are there any negative environmental issues related to these materials?
  - How have the aesthetics changed, and what impact have these changes had on the visual appeal of the product?
- Work with students to develop criteria that will be used to assess their research presentations on the development of a product design. Criteria might include:
  - use of a variety of relevant sources of information
  - accuracy of information
  - use of correct terminology
  - effective presentation of information
  - identification of impact of specifications on the design process
- Have students conduct hands-on research to compare and contrast a variety of manual and electronic drawing techniques and communication methods while working in "companies" that design, develop, and market products. As the teams demonstrate their findings to the class, note their abilities to:
  - identify the strengths and limitations of the various drawing techniques
  - clearly communicate their ideas using various communication methods (e.g., multimedia, flow charts)
  - clearly delineate the levels of responsibility for specific tasks related to the design, development, and communication of ideas
  - work collaboratively in their "companies"

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Design Graphics
- Electrical/Electronic Systems
- Energy
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology at Work
- Industrial Design
- Inside Combustible Engines
- Land Transportation
- The New Digital Imaging
- Sea Transportation
- Technology for the Disabled

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Welcome to...Macintosh Multimedia
- Welcome to...PC Sound, Music, and MIDI

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- solve design problems using a variety of strategies
- assess the appropriateness of design solutions
- demonstrate ability to collaborate to analyse and solve design and communication problems

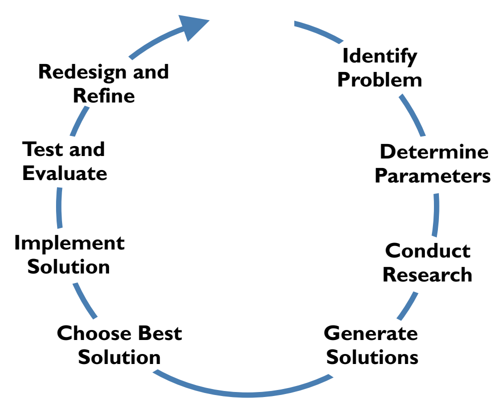
SUGGESTED INSTRUCTIONAL STRATEGIES

Students develop design and communication skills as they work collaboratively to solve design problems. As they look at examples from today's global marketplace and create their own design solutions, they develop an awareness of and ability to select problem-solving strategies.

- Challenge groups of students to review and incorporate strategies from various problem-solving models in order to develop and present advertisements for an electricity-powered commuter vehicle. Have them identify criteria to use as a framework for their ads (e.g., target audience, cost benefits to consumer, environmental considerations, ease of access). To encourage all students to actively participate, review with them the roles and expectations of working collaboratively in groups. As they work to design their ads, ask them to research various processes advertisers use to communicate ideas. When groups present their ads, have them describe the problem-solving strategies they used.

Designing

Designing is a problem-solving method used to develop solutions leading to the creation of articles, systems, or environments.



- Work with students to generate criteria to assess the form, function, and aesthetic value of a computer joy stick or remote-control device for home entertainment centres. Have them bring examples from home. Ask groups of students to use the criteria to evaluate the items. Challenge them to suggest improvements to the designs and to justify their suggestions based on the criteria.

SUGGESTED ASSESSMENT STRATEGIES

As students work collaboratively on design and communication problems, they can demonstrate effective problem-solving strategies.

- Observe students as they apply problem-solving models to develop advertisements. To assess student understanding, consider the following:
  - How actively are students engaged in solving the problem?
  - Are students able to access previous knowledge to solve the problems?
  - What strategies do students employ to generate specifications for the advertisements?
  - How do students incorporate suggestions from their peers while working on the design problems?
- Collect the design briefs for students' advertisements and look for evidence that they are able to:
  - identify the intended audience
  - identify the impact that the product manufacturer wants the advertisement to have (e.g., subtle, shocking)
  - choose a method or methods of communication that suit the design and delivery of the advertisements
  - identify appropriate sources of information to assist in the design of the advertisements
- As students investigate and report on the effectiveness of various communication processes, note their abilities to:
  - use a variety of sources to locate information (e.g., on-line, electronic, interviewing)
  - provide criteria that support their choice of methods used to design their advertisements (e.g., numbers of persons reached, visual effect, impact of message, cultural bias)
  - use correct terminology
- Assess student-developed criteria for remote-control devices or joy sticks for evidence that students are able to:
  - identify criteria relevant to each type of product
  - consider possible users for each product when developing criteria

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Electrical / Electronic Systems
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology at Work
- Industrial Design
- Inside Combustible Engines
- Land Transportation
- The New Digital Imaging
- Sea Transportation
- Technology for the Disabled

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Welcome to...Macintosh Multimedia

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- develop and present design solutions using:
  - manual and computer drafting
  - prototypes and models
  - multimedia
  - computer animation or simulation
- interpret and create accurate design representations
- select and use materials and components in designs to reflect specific design criteria and community standards
- apply concepts from other disciplines to the design process

SUGGESTED INSTRUCTIONAL STRATEGIES

As students develop designs to meet specific criteria and communicate their ideas to others, they develop an understanding of the design process and effective communication strategies.

- Challenge students to design personal logos. Have them use manual drafting, graphic design programs, or CADD to develop and communicate their design solutions. As an extension, encourage students to develop computer simulations, videos, or audio productions to enhance or extend their designs. Have them include all their work, from early concept sketches to final products, in design portfolios. Ask them to include descriptions of the processes and strategies they used, and discuss how the designs evolved during development.
- Have teams of students set up "companies" to design and develop recreational products (e.g., high-tech kayak paddle). Before they begin, ask them to develop work plans and organizational charts, and to assign individual group members specific tasks and responsibilities related to the design or to product development (e.g., project manager, research team member, business manager). Invite students to use a variety of drawing techniques (e.g., sketching, manual drafting, CADD), communication processes, and media to create and communicate their designs from concept to finished product.
- Have groups construct scale models or prototypes of their design solutions. Ask them to select production methods and materials in order to address:
  - cost-effectiveness
  - aesthetics and functionality
  - environmental considerations
  - audience appeal

  As they work to develop their models, discuss with students the proper applications of WCB and WHMIS safety regulations.

SUGGESTED ASSESSMENT STRATEGIES

As students create design portfolios and prototypes, they can demonstrate their understanding of the design process and effective communication techniques.

- As teams of students work to design recreational products, have them develop design portfolios. Collect their design portfolios and look for evidence of their abilities to:
  - clearly identify the design problems
  - generate a variety of ideas
  - use manual drafting and CADD skills and graphic design software to develop their chosen solution
  - communicate their design solutions in a logical order
- Ask students to maintain journals as part of their design portfolios. To assist them in recording their thoughts, have them consider the following questions:
  - What did you do first?
  - Where did you go to find information relating to your design?
  - What are the strengths and weaknesses of your design?
  - What unforeseen problems did you encounter, and how did you deal with them?
- Work with students to develop a rating scale for a product or prototype. Criteria might include:
  - satisfies specific design parameters
  - durable
  - stable
  - safe
  - easy and cost-effective to manufacture
  - performs well on an objective test
  - aesthetically pleasing
- Have students examine their design portfolios and prototypes. To focus their reflection, pose questions such as:
  - How did you redefine the design problem as you worked?
  - How did you choose materials to best match the specific product requirements?
  - How did you address the issue of waste management in the manufacturing process?
  - What modifications could you make to improve your product?

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Design Graphics
- Electrical/Electronic Systems
- Project Design
- Tracktronics

Video

- Ecological Design
- Energy Choices
- Fluid Power Technology at Work
- Industrial Design
- The New Digital Imaging
- Technology for the Disabled

Multimedia

- Orientation to WHMIS

Games/Manipulatives

- The Building Box: Model #2

CD-ROM

- Mitchell...Estimating System
- Welcome to...Macintosh Multimedia
- Welcome to...PC Sound, Music, and MIDI

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- describe processes and components involved in manufacturing and production
- compare the characteristics and properties of materials used to manufacture or produce products or systems
- describe the forces that act on structures that must be taken into account when designing, manufacturing, or producing products or systems, including:
  - stress
  - static and dynamic loads
- identify impacts of production and manufacturing processes on society and the environment
- identify entrepreneurial opportunities in production and manufacturing

SUGGESTED INSTRUCTIONAL STRATEGIES

As students work individually and in groups to evaluate the characteristics, properties, and production of existing products, they develop an awareness of materials and processes used in product development.

- Present students with a variety of natural and composite construction materials. Have them describe the characteristics (texture, colour, finish), properties (hardness, density, strength), and appropriate uses for each.
- Ask groups of students to each select a product such as a table or desk to analyse. Have them list the integral components, formulate possible methods of construction (e.g., panel and rail), develop flow charts to show the order of assembly, and present their findings to the class. As an extension, ask groups to analyse the structural integrity of the products, focussing on how the effects of forces were considered in the products' development.
- Have students compare similar products made by different manufacturers (e.g., CD racks, office chairs, running shoes). Challenge students to develop "product sheets" to list the advantages, disadvantages, and special features of each design (e.g., structure, function, effect of forces, aesthetics, ergonomics, materials).
- Invite groups of students to each select an assembled item such as a refrigerator, snowmobile, or hair dryer. Ask them to use a variety of information technology tools to research and prepare reports about the products' development, impact on society, and long-range effect on the environment.
- In teams, have students brainstorm questions to ask a person currently involved in the manufacturing or production field. Encourage them to develop questions to find out information on:
  - career preparation and educational requirements
  - tasks and responsibilities
  - the work environment, including information about gender and cultural diversity

SUGGESTED ASSESSMENT STRATEGIES

As students choose materials for the development of products, they can demonstrate their knowledge of characteristics and properties of materials and of the criteria to be considered in choosing them.

- Present samples of construction materials to students and have them describe their characteristics and properties. Note their abilities to:
  - identify the materials by name
  - suggest appropriate applications of these materials in manufacturing and production
  - list where they have seen the materials used, and give possible reasons for their use
- Observe teams of students as they analyse products, and note the extent to which they are able to:
  - identify the integral parts
  - suggest possible methods of construction for those parts
  - illustrate the order of assembly of the products
  - present information in a logical sequence
- After students review similar products and develop product sheets, ask them to demonstrate their findings to the class. Note their abilities to:
  - identify appropriate criteria for comparison (e.g., structure, function, aesthetics, materials, safety)
  - identify the advantages and disadvantages of one product versus another, using the criteria
  - identify the effect of forces (e.g., stress and strain, static and dynamic loads) in product development
  - use correct terminology
- Have students interview people currently working in a manufacturing or production field and prepare presentations based on their research. During the presentation, look for evidence that students are able to identify:
  - educational training required
  - duties and responsibilities related to the job
  - patterns of participation with respect to gender and cultural diversity
  - the impact of technology on the occupation

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Electrical/Electronic Systems
- Energy
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Air Transportation
- Ecological Design
- Energy Choices
- Fluid Power Technology
- Fluid Power Technology at Work
- Fundamentals of Aeronautics Technology
- How Airplanes Work
- Industrial Design
- Introduction to Fluid Power
- Land Transportation
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Mitchell...Repair Information System

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- analyse the effect of design elements in a production process, based on the following factors:
  - principles of engineering
  - standards of quality and reliability
  - reduction of waste
- communicate solutions to problems encountered in product development
- demonstrate an understanding of the steps involved in managing product development projects

SUGGESTED INSTRUCTIONAL STRATEGIES

Students learn to draw on the principles of product development and learn product evaluation skills to solve problems related to the development of products or systems. They develop these skills and this understanding as they work individually and in groups to evaluate production processes and solve problems.

- In teams, challenge students to apply their understanding of problem solving by developing products for a current or future market (e.g., an age-specific children's toy, a device that enhances a student's locker, luggage that meets airline regulations).
- Provide students with commercial drawings, plans, or schematics, and have them develop project-management materials (e.g., construction schedules for a greenhouse, parts lists for an electric wheelchair, cutting plans for an Adirondack chair, patterns for a lightweight tent).
- At the end of a team project, have students suggest ways to improve on the processes and products they have completed. Challenge them to assess the products using criteria based on design elements and to evaluate individual team members' contributions. Ask them to summarize their discussions by developing action plans to modify the products and manage their development.

SUGGESTED ASSESSMENT STRATEGIES

As students work individually and in groups to develop products, they can demonstrate their abilities to apply problem-solving and project-management strategies.

- As students begin to work on designing children's toys, ask them to research standards of quality and reliability and to apply those in their designs. Note the extent to which students are able to:
  - identify appropriate sources of information
  - identify standards that apply to their toys
  - develop designs to meet identified standards
- After students have completed their product designs, have them self-assess their group problem-solving skills. Prompt students with questions such as:
  - What problems came up as you developed your product?
  - What did you do when you encountered difficulty?
  - Were you able to redefine the design problem as you went along?
  - If you were to start again, what would you do differently?
  - What did you learn that you can apply to other projects?
- Have students in groups suggest design improvements for their completed projects. Observe the extent to which they are able to:
  - identify weaknesses in their designs
  - generate ideas that will improve the design of their products
  - develop plans to address the design changes
  - work independently and co-operatively to produce design changes
- As a post-production activity, ask design teams to investigate waste management. Assess the extent to which students are able to:
  - identify areas of waste
  - suggest several ways of reducing waste
  - suggest possible methods of recycling or reusing materials

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Design Graphics
- Electrical/Electronic Systems
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Air Transportation
- Ecological Design
- Energy Choices
- Fluid Power Technology at Work
- Fundamentals of Aeronautics Technology
- How Airplanes Work
- Industrial Design
- Introduction to Fluid Power
- Land Transportation
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- produce finished products or systems from plans or designs (drawings, plans, schematics)
- apply the processes of combining, forming, seperating, and finishing
- develop and modify products or systems to address:
  - principles of engineering
  - standards of quality and reliability
  - waste reduction
  - specified design criteria (form, function, aesthetics, ergonomics, end-user needs)
- apply safe work habits in accordance with established regulations, including WCB and WHMIS regulations

SUGGESTED INSTRUCTIONAL STRATEGIES

Students need hands-on opportunities to safely perform the process of combining, forming, separating, and finishing. As they collaborate to create products or systems, they learn to adapt materials and processes to address production constraints and technological change.

- Guide students as they assemble design portfolios to show the development of a product or system from conception to completion. Provide lists of items to include, such as:
  - drawings, including initial sketches, design briefs, and formal design representations showing several views, structural details (e.g., cutaway views to show joint detail), and dimensions
  - production details, including descriptions of why they selected specific materials, particular fabrication techniques used, and regulations associated with health and safety standards
  - photographs and drawings that show the product in various stages of development, including several views of the completed product
- Give students guidelines, such as the sample below, for selecting product development materials.

Criteria	Examples
Responsible to Environment	Select lumber and other materials in ways that use products efficiently.
Cost-Effective	Do cost comparisons to identify the most appropriate material to accomplish tasks.
Budget Control	Keep a record of materials and costs.

- When students complete products, have them review their design portfolios, list the problems they encountered during product development (e.g., structural flaws, incorrect measurements, difficulty of assembly), list the appropriate technical processes used (in accordance with WCB and WHMIS regulations), and note whether the finished products met design criteria. Ask students to describe how the finished products reflect the original designs and to justify alterations they made to these designs.

SUGGESTED ASSESSMENT STRATEGIES

As students modify products or systems, they can demonstrate their abilities to identify standards, choose materials, apply processes, and comply with safety regulations.

- While students are working on design projects, look for the use of safety equipment and procedures. List any observed safe practices on the chalkboard, and have students add to the list. Use the results to develop a checklist for teacher and student use.
- As students work on developing design portfolios for a product, observe the extent to which they are able to:
  - generate a variety of ideas for the product design
  - communicate their ideas using all necessary drawings
  - support their reasons for selecting materials
  - accurately describe the fabrication techniques used
  - address the application of health and safety standards
- Work with students to establish criteria to assess the drawings in their design portfolios. These might include:
  - visual presentation (e.g., neatness, clarity)
  - accuracy
  - level of detail (e.g., cutaway views)
- Have students demonstrate their safety knowledge in a performance assessment that includes:
  - a pre-production set-up (e.g., safety guards in place, proper blade for material being cut)
  - a personal safety check (e.g., eye or face protection, ear protection, respirator)
  - a material processing check (e.g., correct speed and feed rate, using relief cuts, extra hold-down devices)
  - identification and reporting of damaged or broken tools or equipment
- Have students self-assess their design portfolios by completing sentence stems such as:
  - Two areas of strength in my design were ____________.
  - I was able to test the effectiveness of my product design by ____________.
  - The part of the design that I would change if I made this product again is ____________.

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Design Graphics
- Electrical/Electronic Systems
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Ecological Design
- Energy Choices
- Fluid Power Technology at Work
- Inside Combustible Engines
- Land Transportation
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module
- Orientation to WHMIS

Games/Manipulatives

- The Building Box: Model #2

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- summarize developments in computer and microelectronics technology related to systems integration, including:
  - electrical
  - electronic
  - pneumatic
  - hydraulic
  - mechanical
- demonstrate an understanding of the application of computer control, including characteristics and configurations
- describe the performance of systems and subsystems in terms of input, process, and output
- describe the functions of analogue and digital components

SUGGESTED INSTRUCTIONAL STRATEGIES

As students view models and actual systems, respond to questions, and research ideas, they apply their understanding of the principles of systems integration in the development of new systems.

- Provide students with an overview of sound reproduction from analogue to digital to illustrate how performance and reliability have improved as technology has advanced. Have them choose similar changes in other systems (e.g., mechanical to electronic switching systems) and research and report their findings to the class.
- Present students with a diagram, including a cutaway of a thermostat. Explain the function of each component and how it works. Ask them to identify applications of thermostats at home, at school, and in industry. As an extension, have students list careers associated with repairing these types of systems and emerging changes in these occupations.
- To help students understand how computer-controlled systems can monitor many inputs simultaneously, ask them to determine the fuel requirements for an electronic fuel-injection engine. Have them make a list of the variables they need to consider.

Variables	How is it Monitored?	Effect on Fuel Requirements
Air Temperature		
Water Temperature		
Throttle Position		
Load		
Engine RPM		
Air Density		
Altitude		
Manifold Pressure		
O_2 Content		

SUGGESTED ASSESSMENT STRATEGIES

As students study integrated systems, they can demonstrate their understanding of sensors, actuators, and feedback loops.

- Have small groups of students investigate a variety of discarded control devices from home, school, or industry. Ask each student to make a short oral presentation on one of these devices to the rest of his or her group. Observe the presentations for evidence that students are able to:
  - identify inputs, outputs, and process and feedback components
  - identify individual components of the control devices and their functions
  - explain how the devices monitor and sense
  - identify practical applications for these devices
  - use correct terminology
- Have students analyse a robotics system and identify the various subsystems by answering the following questions:
  - What is the power source?
  - What types of sensor are used?
  - How are the actuators utilized?
  - What feedback systems are incorporated?
- Ask students to submit charts and reports demonstrating their understanding of how a computer-controlled system can monitor many different inputs simultaneously (e.g., an electronic fuel-injection system). Note to what extent they are able to:
  - identify how each of the variables is monitored
  - use correct terminology
  - identify what effect a change in a variable would have on the requirements (e.g., fuel delivery in a fuel-injection system)
- Have students research developments in a particular area of computer or microelectronics technology (e.g., video editing, computer systems in cars, microchip technology), and ask them to reflect on what they have learned by completing the following sentences:
  - One thing I learned that surprised me was ____________.
  - Two applications of this technology are ____________.
  - A way this technology might be advanced in the future is ____________.

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical/Electronic Systems
- Energy
- Tracktronics

Video

- Ecological Design
- Energy Choices
- Fluid Power Technology
- Fluid Power Technology at Work
- Introduction to Fluid Power
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- Digital Electronics Kit

CD-ROM

- Mitchell...Repair Information System
- Welcome to...PC Sound, Music, and MIDI

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

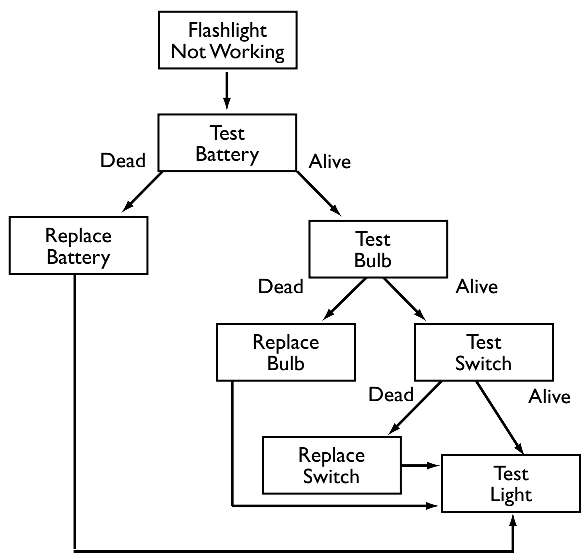
- assess the performance of systems and subsystems using test equipment and prescribed procedures
- justify solutions to systems integration problems
- demonstrate personal responsibility in group efforts to identify and solve systems integration problems

SUGGESTED INSTRUCTIONAL STRATEGIES

Identifying problems in integrated systems is fundamental to a career in technology. Students gain effective troubleshooting skills through hands-on experiences and by illustrating the paths they use to isolate and diagnose malfunctions.

- Discuss with students the versatility of a multimeter. Have them use a multimeter to diagnose a non-working circuit (e.g., flashlight, cyborg). Then ask them to produce flow charts of the testing procedures they used. To facilitate student understanding of the use of flow charts in solving system problems, pose questions such as:
  - How was the multimeter useful in this process?
  - How do you establish priority for each step?

Systems Flow Chart



- To facilitate student understanding of the use of test equipment and diagnostic procedures, have one group of students use equipment to randomly test a non-working circuit while another group uses logic to develop a flow chart for assessing performance. Discuss with students the relative merits of the two procedures (e.g., cost-effectiveness, accuracy).
- Provide teams of students with faulty circuits (e.g., circuit board, alternator). Have each team sketch a flow chart to locate the fault (e.g., open circuit, short circuit). Then ask each to create a new fault and challenge another group to locate the fault using the flow chart.

SUGGESTED ASSESSMENT STRATEGIES

As students assess the performance of systems and subsystems, they can demonstrate their abilities to use test equipment, apply diagnostic procedures, and develop flow charts.

- When students are engaged in troubleshooting, note the extent to which they are able to:
  - approach the problem systematically
  - identify interrelationships among various parts
  - identify the impact of a failed component on the system
  - explore alternative solutions
  - use tools and testing equipment to facilitate the troubleshooting process
- Collect students' flow charts of troubleshooting procedures used to determine a malfunction in an integrated system. Look for evidence that students are able to:
  - identify the purpose of the subsystems
  - systematically test the subsystems to isolate the malfunction
  - identify the cause of the malfunction
  - explore and test alternative solutions
- Conference with students individually about their contributions to their troubleshooting teams. Pose questions such as:
  - What were your specific contributions to the group?
  - As your group encountered problems, what strategies did you use to help?
  - What will you do differently next time?
- After students work in a group problem-solving situation, ask them to reflect on their problem-solving skills by individually responding to the following sentence stems:
  - One thing I had difficulty understanding was ____________.
  - Some things I already knew that helped me work on this problem were ____________.
  - One strategy I suggested to the group was ____________.
  - An idea I got from another group member was ____________.

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical / Electronic Systems
- Energy
- Tracktronics

Video

- Ecological Design
- Energy Choices
- Fluid Power Technology
- Fluid Power Technology at Work
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Mitchell...Repair Information System

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- use computer systems to control machines or devices
- select and use a variety of input and output devices to achieve specific purposes
- construct control systems or robotics devices that connect components, including:
  - controller
  - manipulator
  - end effector
- design and construct electronic systems to recognized community standards that incorporate electronic components and development processes

SUGGESTED INSTRUCTIONAL STRATEGIES

As they observe, disassemble, and assemble simple machines and other technological devices, students develop an understanding of the workings of more complex machines.

- After students connect and test various circuits (e.g., motion sensor for a light switch), have them demonstrate their understanding of how to integrate controllers, manipulators, and actuators. Ask them to use either a trainer, paper-and-pencil drawings, or a prototype to illustrate integration. As an extension, have students design and construct the devices.
- Demonstrate the use of CNC equipment in manufacturing a product. Have students develop a simple product using integrated CAD, CAM, and CNC software.
- Present students with tools or simple machines (e.g., electric hand drill, air drill). Ask them to work in teams of three (technologist, end-user, engineer) to critique strengths and limitations of each machine or tool (e.g., size, weight, length of cord) and to describe the safety standards for each (e.g., applicable safety and WCB codes).
- Have each student design, construct, and program a robot that will:
  - follow a path
  - trace a maze
  - go in circles
  - go up and down
  - make two movements

  Emphasize that the devices should include controllers, manipulators, and effectors.

SUGGESTED ASSESSMENT STRATEGIES

As students develop machines or devices, they can demonstrate their abilities to select and use a variety of input and output devices to achieve specific purposes.

- Have students demonstrate their understanding of how to use software to control a machine or device by making presentations to a group of younger students. Watch for evidence of:
  - selection of appropriate commands
  - use of correct terminology
  - clarity of explanation
- Have teams of students role-play consumer groups and analyse a system or device for safety and function. Observe the extent to which students are able to:
  - identify industry standards for the system or device
  - identify the working features of the system or device
  - identify any potentially unsafe features
  - suggest realistic ways the unsafe features could be corrected
- Collect student-constructed robots that include the use of controllers, manipulators, and effectors. Note the extent to which the robots:
  - meet the initial criteria
  - function effectively
  - perform the predetermined commands
- Have students reflect on the safety of one of the electronic systems they have constructed by answering questions such as:
  - What codes or standards did you comply with or should have been complied with in the construction or operation of the system or device?
  - What modifications could you make to ensure that the system or device is safer for the user?

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical / Electronic Systems
- Energy
- Tracktronics

Video

- Ecological Design
- Energy Choices
- Fluid Power Technology
- Fluid Power Technology at Work
- Introduction to Fluid Power
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module
- Orientation to WHMIS

Games/Manipulatives

- Digital Electronics Kit

CD-ROM

- Mitchell...Repair Information System
- Welcome to...PC Sound, Music, and MIDI

Prescribed Learning Outcomes

It is expected that students will:

- compare ways of using emerging and alternative energy sources to power mechanical devices
- describe the relationship between potential and kinetic energy in making a mechanism function
- demonstrate an understanding of the principles of hydraulics and pneumatics used to transmit energy
- describe workplace applications in which technicians measure, control, convert, and transmit energy in various systems
- describe the impact of energy, power, and transportation systems on society and the environment

Suggested Instructional Strategies

Students learn how mechanical systems and devices convert, transmit, and use energy by observing, researching, and discussing the functions of various components used in transportation.

- During a unit on fluid power systems, discuss with students the advantages and disadvantages of pneumatic and hydraulic systems in terms of precision, weight, and responsiveness. Provide examples (brake systems, assembly lines, suspension systems) to show how these systems are applied and how they transmit energy. As an extension, have students calculate the force of each example system (e.g., relate piston diameter and applied fluidic pressure to force exerted).
- Engage students in a discussion of the benefits and drawbacks of various transportation systems, including how they affect society and the environment (e.g., electric commuter rail creates less direct pollution). Have students each choose a mode of transportation and research its future potential. Ask them to consider existing, emerging, and alternative energy sources in their projections. Pose questions such as: Will commuter rail be the same 25 years from now?
- Have students gather examples, pictures, and descriptions of devices that clamp, ratchet, reciprocate, and rotate. For example, students might bring toys, owner's manuals, technical publications, and magazine ads that demonstrate or describe devices that perform various movements (e.g., levers, gears) and functions (e.g., torque multiplication, speed increase). Ask them to describe the purpose and function of each device and to discuss how these devices rely on potential and kinetic energy to achieve specific outcomes.
- Have students research career opportunities in the technical field, where measurement, transmission, and control of energy form an integral part of the job.

SUGGESTED ASSESSMENT STRATEGIES

As students describe and show the various components used in transportation, they can demonstrate their abilities to identify energy sources and conversions in mechanical devices.

- Ask students to research alternative sources of energy and their uses and to present their findings to the class (e.g., oral presentation, chart, poster, computer presentation). Look for evidence that they are able to:
  - identify practical applications
  - describe how the forms of energy are converted to other forms
  - predict future applications
- Through conferencing, either with individual students or with groups, determine the extent to which they have developed an understanding of the principles of transfer and conversion of energy within mechanical systems. Ask questions such as:
  - What have you designed that has converted potential energy to kinetic energy?
  - How is energy transferred within your system?
  - What practical applications might your system have?
- Assign students to interview technicians who are responsible for the measurement and control of energy, or research companies where these technicians work. Note the extent to which students are able to:
  - identify the units of measurement
  - identify the instruments used
  - identify the devices used to control the energy
  - use correct terminology
- Have students imagine they are members of a town council debating the best way to provide power for their town. Ask them to select different power sources and present persuasive arguments for each, based on cost-effectiveness, environmental considerations, social implications, and so on. Note the extent to which they are able to:
  - identify relevant information
  - identify the characteristics and impacts of each power source
  - support their positions with factual information
  - recognize ambiguities and contradictions

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical / Electronic Systems
- Energy
- Tracktronics

Video

- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology
- Fluid Power Technology at Work
- Fundamentals of Aeronautics Technology
- How Airplanes Work
- Inside Combustible Engines
- Introduction to Fluid Power
- Land Transportation
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- measure the efficiency and performance of systems that use contemporary energy sources
- perform test procedures on computer-equipped energy systems and communicate results
- diagnose and repair problems in electrical and mechanical devices and systems
- apply teamwork skills to solve problems involving mechanical systems and subsystems

SUGGESTED INSTRUCTIONAL STRATEGIES

Problem solving is the basis for designing, constructing, diagnosing, and repairing systems involving energy and power. As students follow specified procedures and reflect on the effectiveness of strategies they select, they learn to identify problems and apply appropriate problem-solving strategies, including researching, troubleshooting, and brainstorming innovative solutions.

- Ask students to gather and use information from a variety of sources (e.g., the Internet, CD-ROMs, technical journals) to solve a technological problem (e.g., describe an optimal gearing for a vehicle to maximize fuel efficiency; examine fossil-fuel alternatives to power vehicles). Have them synthesize the information they gather, generate alternatives, assess the merits of various solutions based on the literature, and create action plans.
- Have students work in teams to develop checklists to assess and diagnose the efficiency of an engine that uses computer-equipped energy systems (e.g., computerized fuel-injection systems). Ask them to include criteria for fuel efficiency, acceleration, speed, emissions, and ignition system operations. Using information from a variety of sources (e.g., repair manuals, CD-ROMs, technical journals), challenge students to calibrate and optimize (tune up) the engine based on their assessments, using the checklists as a guide. Have them use charts to record their findings.

Pre-Modification Data		Modification	Post-Modification Data
Fuel Efficiency	L/100 km	Carburetor Adjustment	L/100 km
Acceleration	0 – 30 km/h in 9.2 s.	Tune-Up	0 – 30 km/h in 8.1 s.
Top Speed	65 km/h	Tune-Up	80 km/h
Emissions	0.25 ppm	Clean Air Filter	0.0075 ppm
Ignition System Plugs	Oily	Timing	Good Burn

Check to see that they use correct terminology when they refer to parts and procedures and communicate diagnostic data.

SUGGESTED ASSESSMENT STRATEGIES

As students evaluate or improve the efficiency of energy systems, they can demonstrate their abilities to analyse problems, generate ideas, and evaluate solutions.

- Have students form teams of consultants to investigate and report on the efficiency of a variety of home heating systems, using information sources such as the BC Hydro Power Smart program. Note the extent to which students are able to:
  - identify and describe various methods of measuring efficiency
  - use correct terminology when describing heat transfer
  - support their conclusions with factual data
- When students tune up a modern computer-controlled engine, watch for evidence that they are able to:
  - apply valid test procedures to verify that the computer system is performing properly
  - interpret technical manuals
  - use correct terminology to communicate faults, ideas, and procedures
- Conference with students individually about their contributions to their design teams. Pose questions such as:
  - What were your specific contributions to the group?
  - As your group encountered problems, what strategies did you use to help?
  - What will you do differently next time?
  - What specific things did you do to initiate, develop, or sustain interactions in the group?
  - How did you build on the ideas of others?

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical / Electronic Systems
- Energy
- Tracktronics

Video

- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology at Work
- Inside Combustible Engines
- Land Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- Digital Electronics Kit

CD-ROM

- Mitchell...Estimating System
- Mitchell...Repair Information System

Prescribed Learning Outcomes

It is expected that students will:

- transfer and convert energy to achieve specific objectives
- manipulate systems and subsystems that use energy and power, including:
  - mechanical
  - hydraulic
  - electrical
  - electronic
- use tools and equipment accurately and efficiently to achieve design and assembly specifications that meet manufacturer and industry standards
- construct a device or system that is energy efficient

Suggested Instructional Strategies

Students learn to design, manipulate, and construct components to improve the efficiency and performance of simple systems related to transportation. They need to be able to modify and manipulate systems and devices in order to function effectively in today's technical environment.

- Have students compare a high-mileage vehicle, a high-performance vehicle, and a transport vehicle to examine relationships between wheel size, gear ratio, and efficient energy transmission and conversion. As a team project, challenge them to apply principles of transmission and conversion to design and build vehicles powered by alternative energy sources (e.g., wind, solar). Hold a competition to see which group's vehicle covers the greatest distance.
- As part of a unit on energy conversion, show and discuss with students six systems common to all internal combustion engines (mechanical, lubrication, fuel, ignition, starting, cooling). Have students describe the function and interaction of each system as they work in teams to disassemble and accurately reassemble a small engine. As an extension, ask them to apply their understanding of the systems to other forms of transportation (e.g., air, water).
- Facilitate students' understanding of the principles of hydraulics by having them experiment with hydraulic, electrical, and pneumatic systems on a demonstration panel. To extend their understanding, ask them to disassemble a brake system, then identify its components (e.g., shoes, slave cylinder, caliper, pistons, springs), assess faults (e.g., leaking wheel cylinder or caliper, damaged rotor), and repair or replace the damaged components as they reassemble the system.
- Supply students with WCB and WHMIS guidelines. As new tools or procedures are introduced, have students model and document the appropriate procedures, based on the guidelines.

SUGGESTED ASSESSMENT STRATEGIES

As students develop energy-efficient systems or devices, they can demonstrate their abilities to manipulate the transfer and conversion of energy in a safe manner to meet design specifications.

- Hold a competition and ask students to produce the best solution to a fuel efficiency problem (e.g., modify a four-stroke gasoline lawn mower engine to deliver better fuel efficiency). Provide opportunities for them to solve mechanical, design, and technical problems to achieve the greatest gains in fuel efficiency. Have students keep journals during the competition. Collect their journals and look for evidence of:
  - design evolution (indicated in thumbnail sketches, notes, and drawings)
  - collaboration on design decisions
  - exploration of a variety of problems and solutions
  - use of prior knowledge to accomplish tasks
- As teams work to produce the longest-running lawn mower engine, conference with each team and ask questions such as:
  - What system of fuel delivery did you choose and why?
  - What problems did your chosen system create, and how did you overcome them?
  - What are the advantages and disadvantages of your system?
- In order to assess how well students use measurement to evaluate their modifications meant to improve the efficiency of mechanical devices, note the extent to which they:
  - perform accurate measurements at all stages of the development of their projects
  - manipulate the measurements to produce usable statistics that aid them in evaluating their progress
  - apply the correct mathematical principles to their data in order to produce meaningful results

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical/Electronic Systems
- Energy
- Tracktronics

Video

- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology
- Fluid Power Technology at Work
- Inside Combustible Engines
- Introduction to Fluid Power
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module
- Orientation to WHMIS

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Mitchell...Estimating System
- Mitchell...Repair Information System

Prescribed Learning Outcomes

It is expected that students will:

- describe relationships among design elements (balance, rhythm, contrast, harmony, proportion, scale)
- describe representation and modelling techniques used to develop design solutions, proposals, and plans
- synthesize knowledge and concepts from other disciplines and the community in the design process
- assess how design reflects society, culture, and the environment

Suggested Instructional Strategies

As students become knowledgable about relationships among design elements and recognize links between design and other disciplines, they are better able to select processes and strategies to effectively solve design problems.

- Provide students with several styles of telephones. Ask them to examine the design elements and to suggest how these elements affect aesthetics and function in each example. Pose questions such as:
  - How does harmony affect the aesthetics of each style of telephone?
  - How do proportion and scale affect the function of each telephone?
  - How does balance affect aesthetics and function?
- Discuss with students a variety of advanced modelling techniques, including computer-generated models, working models, and computer- and video-generated simulations. Provide them with several design activities and ask them to identify the advanced representation and modelling techniques that might be used to develop design solutions and proposals. As an extension, have students each select a product and describe specific techniques they would use to model design ideas for it.
- Ask students to investigate a variety of information-gathering devices (hardware) and processes (software). Challenge them to identify the type of data each is best used for and to describe the benefits of each in manipulating data (e.g., a spreadsheet provides an overview of data). Have them discuss the relative efficiency of each in presentations to the class.
- Have students work in teams to assess the design of familiar items (e.g., houses, automobiles, clothing). Invite each team to select an item, then describe and assess its design in different contexts (e.g., climatic regions) and its function and form. As an extension, ask students to research the development of the products or designs and identify societal, cultural, or environmental influences.

SUGGESTED ASSESSMENT STRATEGIES

As students analyse the design of products, they can demonstrate their understanding of the relationships among design elements and between design elements and culture and environment.

- Ask students to review examples of video games that use advanced modelling techniques, and question them about other applications for these techniques. Note the extent to which students are able to:
  - demonstrate their understanding of the modelling techniques used
  - generate ideas that reflect divergent thinking regarding alternative applications of the modelling techniques
- After a field trip to several stores that sell a variety of products for children, ask students to brainstorm a list of common design elements they noticed. Note the extent to which they are able to identify design elements that:
  - are likely to appeal to children
  - would make the product more functional for children
  - ensure safety
- Have each student make a brief oral presentation to a small group on the relationships among the design elements of a product of her or his choice. Note the extent to which students are able to identify the:
  - design elements
  - impact of the design elements on function
  - impact of the design elements on aesthetics
- Have students work individually or in pairs to interview people in the design communications field and prepare presentations based on their research. Look for evidence that they are able to identify:
  - representation and modelling techniques used by the interviewees
  - duties and responsibilities related to the careers
  - relevant personal attributes and necessary skills

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Design Graphics
- Electrical/Electronic Systems
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Air Transportation
- Ecological Design
- Energy Choices
- How Airplanes Work
- Industrial Design
- The New Digital Imaging
- Sea Transportation
- Technology for the Disabled

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Mitchell...Estimating System
- Welcome to...Macintosh Multimedia

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- assess and modify designs using specific criteria, including:
  - aesthetic factors
  - ergonomic factors
  - cost-effectiveness
  - available resources
  - environmental impact
- apply project-management processes while working on design teams

SUGGESTED INSTRUCTIONAL STRATEGIES

Students learn the importance of project management as they work with others to solve design problems and develop ways to communicate their ideas.

- Have students form teams to assess and predict the effect of a hypothetical design on society, culture, and the environment (e.g., self-contained habitat for areas with harsh climates). Ask students to draw plans based on related knowledge and experiences from previous design situations. The teams then develop reports using data from a variety of sources to support their predictions.
- Ask students to work in small groups to design products or systems (e.g., sunglasses, clothes hanger, remote-control holder). Have them develop outlines or flow charts to assist in managing their projects, including task analyses and management matrices. Then ask each group to assign each member a specific role and responsibility. Have students assess their designs using predetermined criteria, then discuss their roles and how they worked together to complete the designs.
- Work with students to assess several project-management software packages to evaluate the effectiveness of each in managing time, money, and people. Have students produce charts to compare each package in terms of:
  - effectiveness and efficiency in dealing with various project-management tasks
  - cost
  - ease of use
  - usefulness of reports

SUGGESTED ASSESSMENT STRATEGIES

As students develop design solutions, they can demonstrate their abilities to apply prior knowledge and experience, problem-solving strategies, and project-management skills.

- Ask students to work in small groups to modify a design (e.g., converting a lawn mower to a snow blower). Assess their problem-solving skills by noting the extent to which they are able to:
  - persevere with the design problem
  - identify gaps in their background knowledge
  - use a variety of resources to find appropriate background information
  - effectively apply the information to solve the design problem
  - apply previously learned problem-solving strategies
  - communicate their solutions effectively
- After teams of students have completed a design project, have them self-assess their application of project-management skills by completing sentence stems such as:
  - I contributed ideas when ___________.
  - Our group worked well when ___________.
  - Tasks that needed to be completed were identified and described by ___________.
  - The job responsibilities were delegated based on ___________.
  - Based on suggestions from other groups, we altered our design by ___________.
  - When we had problems, we dealt with them by ___________.
- Ask students to develop a set of criteria to evaluate project-management software. Assess the criteria for evidence that students are able to:
  - identify aspects of the software that should be evaluated
  - identify relevant criteria
  - consider the needs of a variety of possible users

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Electrical / Electronic Systems
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Air Transportation
- Ecological Design
- Energy Choices
- How Airplanes Work
- Industrial Design
- Inside Combustible Engines
- The New Digital Imaging
- Technology for the Disabled

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Mitchell...Estimating System
- Welcome to...Macintosh Multimedia
- Welcome to...PC Sound, Music, and MIDI

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- design products and systems and select appropriate materials and components to reflect specified design criteria, including:
  - method of production
  - cost
  - aesthetics
  - function
  - environmental considerations
- use appropriate tools and equipment to develop and present design ideas, including:
  - manual drafting
  - CADD
  - computer animation or simulation
  - video and audio production
  - models
- produce working drawings that incorporate recognized standards

SUGGESTED INSTRUCTIONAL STRATEGIES

As students design complex products and systems, they learn to select appropriate tools and methods of production, evaluate the effectiveness of their designs, and use advanced presentation techniques to communicate their ideas.

- Have students work in co-operative teams to create design portfolios that document in detail the development of their ideas and solutions to design problems. Ask them to include materials (e.g., sketches, formal drafting drawings, computer modelling, multimedia presentations) to document their projects from early conceptualization to final design representation.
- Have students produce assembly drawings and schematics to assist in manufacturing a security system. Challenge them to use information from a variety of sources (e.g., the Internet, CD-ROMs) to ensure that the design reflects industry standards for design representations and security system requirements. As they work, encourage them to select appropriate tools and equipment to develop their design representations.
- As part of a unit on systems, have students apply specific design criteria to develop designs for a chair (e.g., a seating device for computer use). Ask them to select materials and components to ensure that the chair designs:
  - are aesthetically pleasing
  - address ergonomic factors
  - meet safety standards
  - are cost-effective
  - incorporate a range of materials, including recycled and reusable materials

  As an extension, ask students to develop scale models or prototypes to assess whether the designs meet their criteria. As they work, have students ensure that they follow recognized safety standards.

SUGGESTED ASSESSMENT STRATEGIES

As students design products and systems to meet specified criteria, they can demonstrate their abilities to select appropriate materials, production tools, and design and communication tools.

- With students, review the design portfolios they develop for products that they make throughout the course. Look for evidence of increasing:
  - clarity and detail in the design briefs
  - creativity in the types of ideas generated
  - detail and accuracy in the drawings
  - integration of electronic forms of communication in the presentations
- As students work on producing drawings of their product designs, note the extent to which they are able to:
  - identify necessary research information
  - select and use appropriate tools and processes
  - develop working drawings to recognized industry standards
  - use computer animation to further enhance the communication of their design ideas
- Give students design criteria, and ask them to select the materials and components required to manufacture a product that meets the criteria. Look for evidence that students consider the following in their decisions:
  - cost
  - scale of the product
  - production methods
  - safety standards
  - environmental considerations
- Ask students to present their design solutions to the class using appropriate communication tools, and have their classmates complete peer evaluations. To focus the assessment, provide questions such as:
  - Does the presentation provide all necessary details relating to the design solution?
  - Are complex ideas made easy to understand?
  - Is the presentation of professional quality (e.g., logical progression, quality visuals, effectively delivered message)?

RECOMMENDED LEARNING RESOURCES

Print Materials

- Communication Systems
- Design and Plastics
- Design Graphics
- Electrical/Electronic Systems
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Ecological Design
- Energy Choices
- Industrial Design
- The New Digital Imaging
- Technology for the Disabled

Multimedia

- Orientation to WHMIS

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Welcome to...Macintosh Multimedia
- Welcome to...PC Sound, Music, and MIDI

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- evaluate the effects of natural and synthetic materials on the properties, characteristics, and commercial uses of products
- compare computer-assisted production processes (CADD, CAM, CNC, robotics) and assembly-line processes in terms of:
  - efficiency and cost-effectiveness
  - impact on product specifications
  - impact on society
- describe a product or system in terms of its characteristics, including:
  - equilibrium (internal and external forces)
  - compression
  - tension
  - torsion
  - shear
- assess how social, economic, and environmental conditions influence the choice of tools, manufacturing, and production processes used in developing products or systems
- analyse how choices made during the development of products or systems reflect predetermined criteria, including:
  - aesthetics
  - environmental considerations
  - ergonomics
  - cost-effectiveness
  - function

SUGGESTED INSTRUCTIONAL STRATEGIES

Students develop an understanding of product structure, material characteristics, and manufacturing equipment and processes by examining products and materials and exploring how they are manufactured.

- Set out a selection of sample construction materials. Have students differentiate between natural and synthetic materials and suggest possible methods of adhesion or blending (e.g., manufactured brick, synthetic marble, engineered beams). Ask each student to group the materials into appropriate categories, suggest uses for each, and justify his or her suggestions based on observed characteristics (e.g., exterior and interior use, durability, structural integrity).
- Have students select two competing products that were manufactured using different production processes (e.g., a door manufactured in an automated robotics assembly line and a door made by hand). Ask them to compare the products in terms of aesthetics and functionality, and the production processes in terms of:
  - efficiency and cost-effectiveness
  - skill and labour requirements
  - environmental considerations
- Engage the class in a discussion about the ramifications of using materials and natural resources that affect the environment. Have students use a variety of sources to research the social and environmental impact of using environmentally sensitive materials to develop products or systems (e.g., exotic woods from rain forests of the world). Ask students to examine alternative, less vulnerable materials that might fulfil the same production needs, reflecting on aesthetics, market demand, and ergonomics.

SUGGESTED ASSESSMENT STRATEGIES

As students investigate and use a variety of natural and synthetic materials, they can demonstrate their abilities to evaluate materials, tools, and manufacturing and production processes based on various criteria.

- As students work with a variety of natural and synthetic materials, conference with them informally and note the extent to which they are able to:
  - accurately identify the materials by name
  - identify methods used to produce the materials (e.g., blending, adhesion of base materials)
  - identify properties (e.g., strength, weight, weathering characteristics, reaction to water)
  - identify characteristics (e.g., machinability, physical appearance, quality of finish)
  - suggest applications in manufacturing and production
- Have students prepare detailed presentations on a material (e.g., MDF board), including the historical development of it, the process used to manufacture it, its properties and characteristics, and any environmental concerns. Note the extent to which each student is able to:
  - present factual content supported by research
  - use correct terminology
  - identify and discuss environmental issues
- Have students research the social and cultural impact of automation displacing workers in an industry, and prepare video or multimedia presentations for the class. Work with students to prepare a list of criteria that could be used to evaluate the presentations. Criteria could include:
  - presents factual content supported by research
  - sequences ideas in an orderly way
  - identifies social consequences and presents possible alternatives to minimize negative impact
  - uses communication techniques effectively

RECOMMENDED LEARNING RESOURCES

Print Materials

- Design and Plastics
- Electrical/Electronic Systems
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology at Work
- Inside Combustible Engines
- Introduction to Fluid Power
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Mitchell...Estimating System

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- appraise products or systems and justify modifications to design or production processes
- use appropriate technical vocabulary and information technology tools to communicate solutions
- apply business and entrepreneurship principles when developing products or systems

SUGGESTED INSTRUCTIONAL STRATEGIES

Product development provides students with opportunities to analyse and evaluate materials, processes, and technology in all stages of production. Using real-life production issues, students learn to make effective decisions when developing products or systems.

- Have students work in teams to identify design flaws in the school's facilities (e.g., hallway congestion, noise transmission, poor ventilation or lighting). Provide students with copies of the building plans, then ask them to list possible improvements and justify their suggestions using engineering, production, and design principles.
- Ask students to identify and design products that are needed in the community. To ensure that the products they develop will meet end-users' needs, encourage students to conduct background research on the target markets. Once they complete their research, ask them to begin development and also to create final reports that each include a business plan, an account of production costs, and a breakdown of responsibilities. Ask students to present their products to the class and describe how the information they gathered contributed to their designs.
- Have students redesign and, if possible, construct a kitchen or bathroom in a local community facility (e.g., library, recreation centre) as a barrier-free area. Ask them to ensure that the modifications they suggest incorporate current access guidelines and regulations for:
  - counter tops
  - storage facilities
  - washing facilities
  - bathroom fixtures or kitchen appliances
  - lighting and electrical outlets
  - grab rails

  Challenge students to create a scale model of their design and display it at the community facility.

SUGGESTED ASSESSMENT STRATEGIES

As students work on problems in product development, they can demonstrate their abilities to justify modifications to design or production processes in terms of principles of engineering, standards of quality and reliability, reduction of waste, specified design criteria, time, and cost.

- As students examine their school for design flaws and suggest possible improvements, note their abilities to:
  - identify design flaws
  - read plans or blueprints to collect pertinent information
  - generate a variety of viable solutions to address design flaws
  - use appropriate terminology
- After students design a barrier-free kitchen or bathroom, confer with them to assess their abilities to critically analyse their designs. Ask them the following questions:
  - What are the strengths and limitations of your design solutions?
  - What potential safety concerns did you address?
  - Are there any other issues you would address in a subsequent design?
- To assess student thinking, confer with individuals or design teams as they develop devices to suit a particular client with a physical limitation. Ask questions such as:
  - What design parameters did you define based on the user's needs?
  - How will your device meet the user's needs?
  - How else could you have designed the device to meet these needs?
  - What design elements have you incorporated to improve the function or aesthetic appeal of the device?
  - How could you evaluate the effectiveness of your device?

RECOMMENDED LEARNING RESOURCES

Print Materials

- Design and Plastics
- Electrical/Electronic Systems
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Air Transportation
- Cars
- Ecological Design
- Energy Choices
- How Airplanes Work
- Introduction to Fluid Power
- Land Transportation
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Mitchell...Repair Information System
- Welcome to...PC Sound, Music, and MIDI

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

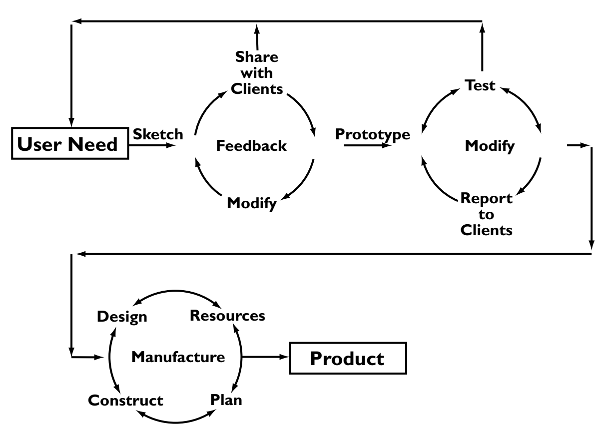
- interpret design representations (drawings, plans, schematics) to assist in developing a product or system
- use computer programs (including CADD, CAM, CNC) to assist in production and manufacturing processes
- apply appropriate production processes (combining, forming, separating, finishing) to create products and systems that conform to:
  - specified design criteria (form, function, aesthetics, ergonomics, end-user needs)
  - recognized standards, conventions, and tolerances
- apply the principles of WCB and WHMIS regulations in their work environment

SUGGESTED INSTRUCTIONAL STRATEGIES

As students modify existing products and develop their own, they learn to safely apply the processes required to develop and improve products or systems to meet community guidelines and standards.

- Divide the class into teams. Ask each to design and construct a component for a barrier-free kitchen or bathroom. As they develop their products, encourage them to incorporate a range of natural and composite materials based on their design proposals and feedback from end-users.
- Have students develop products that enhance the quality of life for someone with physical limitations (e.g., transportation or walking aid). Before they begin production, ask them to develop plans outlining production processes and safety principles they will apply as they work.
- Instruct students about various computer programs that aid production and manufacturing processes (e.g., CADD, CAM, CNC). Guide them in the use of these computer programs to develop products of their choice (e.g., jewellery box, licence plate frame). Have them create design portfolios to track the products' development from conception to final result. Ask them to ensure that they include the following in their portfolios:
  - rationale for their choice of materials
  - descriptions of the production processes involved
  - discussion of the benefits and limitations of using CADD, CAM, and CNC
  - descriptions of the safety strategies they applied

Production Process



SUGGESTED ASSESSMENT STRATEGIES

As students create products and systems, they can demonstrate their abilities to interpret design representations, use computer programs in production and manufacturing processes, and maintain a safe work environment.

- As students produce computer-generated models using appropriate software, note the extent to which they are able to:
  - select appropriate techniques
  - produce professional-quality models
  - effectively represent different materials
  - use the models to explain their design ideas
- Work with students to establish criteria for assessing their grasping or lifting devices. The criteria could include:
  - selection of materials that reflect the requirements of the design proposal
  - reduction of material waste in the production process
  - quality of the finished product in relation to design criteria
- Have students develop design portfolios for a jewellery box that incorporates CADD/CAM/CNC in the production process. Collect their design portfolios and look for evidence that they are able to:
  - support their reasons for selecting materials
  - produce designs that maximize the potential uses of CADD/CAM/CNC in production versus traditional methods
  - identify the limitations of using CADD/CAM/CNC in production
  - select the appropriate cutting tools to perform the various machining tasks
- After students have watched a video or listened to a presentation by the WCB, ask them to reflect on what they have learned by completing sentence stems such as the following:
  - One thing I learned that surprised me was ____________.
  - One thing I can do to improve my safety is ____________.
  - Two things that can be done to reduce accidents are ____________.
  - One thing I am still wondering about is ____________.

RECOMMENDED LEARNING RESOURCES

Print Materials

- Design and Plastics
- Design Graphics
- Electrical/Electronic Systems
- The New Product Development Program
- Project Design
- Tracktronics

Video

- Cars
- Ecological Design
- Energy Choices
- Land Transportation
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module
- Orientation to WHMIS

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

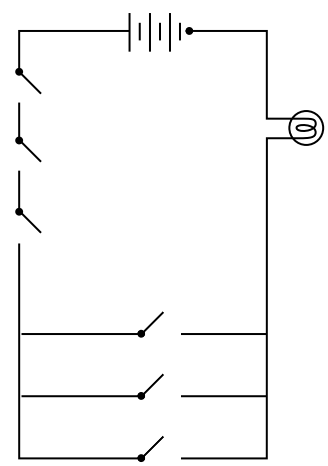
- explain basic digital logic
- explain how feedback is used to correct the functioning of systems and subsystems
- describe systems integration that combines two or more of the following components:
  - electrical
  - electronic
  - pneumatic
  - hydraulic
  - mechanical

SUGGESTED INSTRUCTIONAL STRATEGIES

Students extend their understanding of systems integration by examining the logic used in systems design and the forms of logic applied to systems and subsystems.

- Introduce students to the concept of binary number systems and discuss the design of a schematic circuit that incorporates three switches in series and three in parallel. Challenge them to design and make puzzles of switches in parallel and in series. Then have them share their circuit boards to determine the binary code required to complete the circuits.

Series, Parallel Circuit



- Present students with systems that require a number of detectors or sensors (e.g., an alarm system). When they examine the components, encourage them to consider the system requirements and applications by asking questions such as:
  - Would you use a motion detector in a barn? Why or why not?
  - Would you use a light sensor in a room with blinds? Why or why not?
  - Would you use a vibration sensor in a concrete building? Why or why not?

  As an extension, have students list careers that involve repairing and installing systems (e.g., alarm installer).
- Ask students to identify examples of feedback systems (e.g., speedometer in a car). Then have them sketch a feedback loop, using appropriate terminology (e.g., *input, output, adjust, monitor*).

SUGGESTED ASSESSMENT STRATEGIES

As students work with the materials, tools, and components used to develop integrated systems, they can demonstrate their abilities to apply basic digital logic and feedback loops to correct the functions of systems and subsystems.

- As a performance-assessment task, ask students to demonstrate their understanding of basic digital logic by designing a complex series-parallel circuit. Look for evidence that students are able to:
  - integrate series circuits and parallel circuits
  - apply binary codes
  - use different combinations of switches to demonstrate integrated circuitry
- Collect students' sketches of feedback loops and check that they are able to:
  - include all components
  - use appropriate terminology
- To demonstrate their understanding of interconnected control devices, ask students to direct their classmates in skits that illustrate how the devices they have researched work. Observe students' abilities to identify:
  - individual control devices within each system
  - the function of each device
  - how each control device affects others within each system

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical / Electronic Systems
- Tracktronics

Video

- Cars
- Ecological Design
- Fluid Power Technology
- Fluid Power Technology at Work
- Fundamentals of Aeronautics Technology
- Inside Combustible Engines
- Introduction to Fluid Power
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- analyse and solve problems related to the performance of systems and subsystems
- communicate diagnostic information when solving systems and subsystems problems
- demonstrate teamwork skills in group problem-solving situations

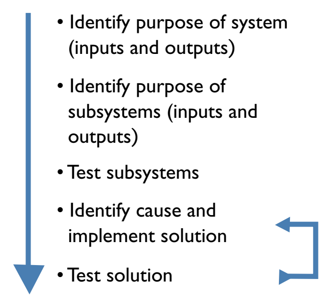
SUGGESTED INSTRUCTIONAL STRATEGIES

Students refine their troubleshooting skills by diagnosing and solving problems that arise in systems. They learn to work with others to solve systems integration problems, summarize information about technical problems, and explain the problems to various audiences.

- In teams, have students use a diagnostic computer to analyse and trace an automotive system failure. Then ask them to diagnose the component of the system that failed.
- Present students with a system problem (e.g., printer will not feed paper properly; vehicle will not start) and diagnostic information about the problem (e.g., flow chart, checklists, comments). Have them summarize the results of the diagnostic information and describe how they would explain the repair options to various audiences (e.g., engineer, consumer). Invite students to relate personal experiences that illustrate effective ways of communicating technical information.

Systems Analysis

Systems analysis or troubleshooting is a problem-solving method used to isolate and diagnose a malfunction.



- Present students with a problem (e.g., VCR that does not function properly). Tell students to use a variety of sources (e.g., owner's or repair manual) to assist in analysing the problem, communicating diagnostic information, and implementing the best solution.
- Have students prepare presentations to explain product repair options and costs to a customer. Brainstorm with students various factors that might influence a customer's decision (e.g., time, durability, cost).

SUGGESTED ASSESSMENT STRATEGIES

As students diagnose and solve problems in complex systems, they can demonstrate their highest levels of problem-solving and group communication skills.

- When students are engaged in troubleshooting, observe the extent to which they are able to:
  - approach the problem systematically
  - identify interrelationships between various parts
  - identify the impact of a failed component on the system
  - explore alternative solutions
  - use tools and testing equipment to facilitate the troubleshooting process
- As students select and use appropriate test equipment to analyse and solve performance problems in systems and subsystems, ask them questions such as:
  - Why did you choose this particular piece of equipment?
  - What other testing unit could you have selected?
  - How did you calibrate the equipment prior to taking readings?
  - What range or scale did you use most frequently?
- Have students role-play repair technicians explaining a systems problem and repair options (e.g., vehicle ignition fault), first to a customer and then to an engineer. Then ask each student to assess his or her own performance by answering the following questions:
  - What points do you feel you communicated clearly and concisely?
  - What points do you feel you had difficulty communicating?
  - How could you have restated these points for more clarity?
  - With which audience (customer or engineer) did you feel it was easier to communicate? Why?

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical / Electronic Systems
- Tracktronics

Video

- Ecological Design
- Fluid Power Technology
- Fluid Power Technology at Work
- Introduction to Fluid Power
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- Digital Electronics Kit

CD-ROM

- Welcome to...PC Sound, Music, and MIDI

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- use sensing devices for feedback in a system or subsystem
- design and construct products that integrate electronic, electrical, pneumatic, hydraulic, and mechanical systems and subsystems, and that meet industry standards
- develop and apply codes for controlling robotics systems

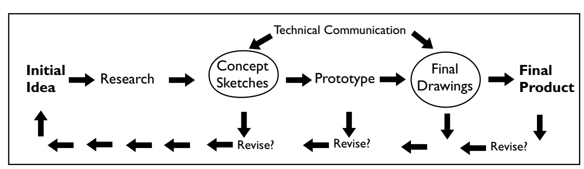
SUGGESTED INSTRUCTIONAL STRATEGIES

Students learn how, in industry, simple devices are integrated to make complex systems. As students design, create, and use simple devices, they gain an understanding of more complex systems and their applications.

- Work with students to identify specific tasks they would like a robot to execute (e.g., tracing a path, stacking blocks, picking and placing). Then have them use a computer control program to make a robot perform the tasks.
- To build on students' understanding of how codes are developed to control a system, ask them to print graphic representations of products of their choice (e.g., gearshift, paperweight) and produce printouts of the tool paths. Then have them use machine codes, or import CADD programs to a CNC machine, to construct the products.
- Discuss with students how electric, electronic, pneumatic, hydraulic, and mechanical systems are integrated to design and construct a functional product. Challenge teams of students to each integrate two or more of the systems to create a product such as:
  - a door opener
  - a residential security system
  - a vehicle security system
  - recreation or exercise equipment

  Inform students that they should include schematic drawings, written descriptions, models, and safety standards required to manufacture the products.

Design Process



- Have students develop owner's manuals to explain the safe operation of products they have created. As they work, encourage them to review various manuals to identify document features they would like to apply.

SUGGESTED ASSESSMENT STRATEGIES

As students resolve complex design problems, they can demonstrate their understanding of how simple devices work together in complex integrated systems.

- As students develop and apply command codes to control a robotics system, observe the extent to which they are able to:
  - create clear graphic representations or tool paths for the finished product or task
  - develop or select the command codes that result in a successful finished product or task
- Collect student projects (and accompanying portfolios) that demonstrate the integration of a number of systems (e.g., door opener, car alarm) and look for evidence that students are able to:
  - use schematic drawings
  - use correct and appropriate construction tools
  - effectively integrate systems
  - include safety considerations in their designs
- Help students analyse a device that uses sensors for feedback in a system by asking them the following questions:
  - What other sensing devices could have been used?
  - Would another sensor have been more efficient?
  - Is there a range of sensitivity that is easily adjusted?
  - Is the device safe for the operator?
- Before students develop owner's manuals for their products, have them examine commercially available manuals to develop a list of criteria for assessing their own documents. When students have completed drafts of their manuals, ask other students to provide feedback by completing sentence stems such as the following:
  - One thing that was very clear and easy to understand was ____________.
  - One thing that was not clear was ____________.
  - A change I would make to the organization of the manual is ____________.
  - Another way you could highlight the safety precautions is ____________.

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Design and Plastics
- Electrical/Electronic Systems
- Tracktronics

Video

- Ecological Design
- Fluid Power Technology
- Fluid Power Technology at Work
- Introduction to Fluid Power
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module
- Orientation to WHMIS

Games/Manipulatives

- Digital Electronics Kit

CD-ROM

- Mitchell...Repair Information System

PRESCRIBED LEARNING OUTCOMES

It is expected that students will:

- describe how types of motion (linear, rotary, oscillatory, reciprocating) are integrated in mechanical systems
- explain the transfer and conversion of energy in devices and systems
- describe ways to integrate emerging and alternative energy sources to power mechanical devices
- apply the principles of kinematics to analyse how mechanisms function
- evaluate social, economic, and environmental conditions that affect the selection of transportation systems

SUGGESTED INSTRUCTIONAL STRATEGIES

Students acquire advanced knowledge of mechanical and electromechanical systems and how these systems convert, transmit, conserve, and use energy and power. In researching industrial and commercial applications of energy, power, and transportation, they also gain an understanding of related career opportunities.

- Review with students the transfer of energy and the conversion of energy by having them calculate mechanical advantage and various ratios (transfer), as well as thermal efficiency (conversion of potential energy to kinetic energy).

Transfer of Energy	gears, belts, pulleys, hydraulics, pneumatics
Conversion of Energy	potential to kinetic, heat energy to mechanical energy

- Introduce students to the principles of kinematics by having them discuss different forms of motion, classifying them as either linear, reciprocating, rotary, or oscillatory. Ask them to develop a dictionary of mechanisms and include definitions of the formulae used to calculate mechanical advantage, diagrams of the functions, and descriptions of the applications.

Forms of Motion	Examples
linear	monorail
reciprocating	bicycle crank
oscillatory	pendulum
rotary	compact disc

- Engage students in a discussion about the factors that influence the design and production of transportation systems (e.g., the impact of pollution on the environment, emissions legislation, diminishing supply of fossil fuels). Have them choose alternative forms of energy to research (e.g., solar, chemical, methane, alcohol) and then develop class presentations about their viability as future energy sources for the transportation industry.

SUGGESTED ASSESSMENT STRATEGIES

As students evaluate the social, economic, and environmental impact of different transportation systems, they can demonstrate their understanding of how systems convert, transmit, conserve, and use energy and power.

- As students analyse problems involving energy transformations, check their understanding by asking them to:
  - identify the energy transformation that occurred and compare it to the work done
  - identify the type of energy possessed by the object before and after the transformation occurred
  - identify energy transformations that take place for specific real-world situations such as amusement rides, car rides, or automobile collisions
- Ask students to work in small groups to design and construct energy transformation devices. Assess the devices using a list of criteria generated by the class with the help of the teacher. The list might include criteria such as minimum efficiency rating attained, amount of work done, and number of energy transformations.
- Have students interview field technicians who are responsible for energy efficiency in their companies, then make brief oral reports to the class. Note the extent to which they are able to:
  - accurately describe the duties and responsibilities of the job
  - describe the gender and cultural diversity among people holding similar jobs
  - identify the educational prerequisites required for entry into the job
  - identify ways in which emerging technology has changed or modified the way the job is done

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical/Electronic Systems
- Tracktronics

Video

- Air Transportation
- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology
- Fluid Power Technology at Work
- Fundamentals of Aeronautics Technology
- How Airplanes Work
- Introduction to Fluid Power
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- Digital Electronics Kit

PRESCRIBED LEARNING OUTCOMES

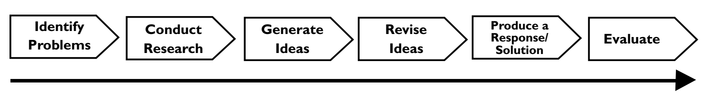
It is expected that students will:

- modify transportation devices and power systems to improve performance or efficiency
- justify strategies and processes used to troubleshoot and diagnose problems
- develop models to test or interpret the action of mechanical devices
- demonstrate ability to work co-operatively in diagnostic teams

SUGGESTED INSTRUCTIONAL STRATEGIES

Students learn to synthesize group feedback in order to identify the best solutions. They learn to identify specific problems, collaborate to create solutions, and develop strategies to implement their solutions in order to improve the performance of mechanical systems and subsystems.

- Have students work in teams to brainstorm ways to adjust wing designs in order to produce maximum lift and minimum drag for an air-based transportation system. Ask them to make models of the wing they believe best achieves the objectives, then test their predictions in a wind tunnel.
- Invite teams of students to brainstorm and develop plans to improve the efficiency of high-performance or high-mileage vehicles (e.g., reduce friction, optimize energy transfer, increase aerodynamic efficiency). Ask the teams to develop and present their action plans to the class, using correct terminology. Then encourage them to use class feedback to modify and implement their plans. As an extension, have the teams evaluate whether their solutions enhanced efficiency and use the results to further modify their vehicles. Students might use the following problem-solving model in the development process:



SUGGESTED ASSESSMENT STRATEGIES

As students work together to improve energy efficiency in a system or device, they can demonstrate sophisticated group problem-solving strategies and processes.

- As students design and construct a high-mileage vehicle, look for evidence of the use of correct technical terminology in their written work and oral descriptions.
- As students design their high-mileage vehicle, encourage them to test modifications to the fuel delivery system, the transmission, and the final gears. Look for evidence that students:
  - experiment with different concepts and technologies
  - test models or vehicles in order to verify their theories
  - record data and apply it to the overall analyses of their projects
  - modify their products to reflect what they have learned from previous tests
  - apply the best solutions to problems, based on analyses of data collected
- When students are engaged in troubleshooting and diagnosing problems, observe the extent to which they are able to:
  - approach the problem systematically
  - identify interrelationships between various parts
  - identify the impact of a failed or inefficient component on the system
  - explore alternative solutions
  - use tools and testing equipment to facilitate the troubleshooting process

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Electrical / Electronic Systems
- Tracktronics

Video

- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology
- Fluid Power Technology at Work
- Inside Combustible Engines
- Introduction to Fluid Power
- Land Transportation
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Mitchell...Estimating System
- Mitchell...Repair Information System

Prescribed Learning Outcomes

It is expected that students will:

- design and construct devices and systems that use one or more energy sources (traditional and alternative) to achieve a measurable outcome
- design and construct electrical, hydraulic, or pneumatic control systems that convert or transmit energy and power
- construct devices and systems that reflect design criteria and industry standards

Suggested Instructional Strategies

Students learn to design, manipulate, and construct increasingly complex systems to improve efficiency and performance while investigating modern and future transportation systems.

- Discuss with students ways to modify a vehicle to improve fuel efficiency (e.g., using lightweight materials and adjusting shape to minimize wind resistance). In teams, have students design aerodynamically efficient vehicles (e.g., boat, glider, high-mileage vehicle, school bus), build scale prototypes, and test them in a wind tunnel.
- Ask student groups to design and build solar, wind, steam, or elastic powered vehicles to meet specific criteria (e.g., size, speed). Hold a competition and award prizes for the fastest vehicle, the one that can pull the most weight, and the most innovative design.
- Have students compare the transmission and conversion of energy and power in a high-mileage vehicle, a high-performance vehicle, and a transport vehicle (e.g., gear ratios, wheel size, engine rpm). As part of a school project to develop a high-performance or a high-mileage vehicle, challenge students to select and adapt or design and build the transmission that will perform most efficiently. Work with students to ensure that they incorporate safety standards and use tools and equipment accurately and efficiently.
- Ask students to design and construct a remote door opener for a person in a wheelchair. Ask them to incorporate electrical, hydraulic, or pneumatic actuators in their designs. As part of the activity, have the class visit community facilities to analyse devices already in use. As a follow-up, invite students to demonstrate their remote door opener designs to the facility members.

SUGGESTED ASSESSMENT STRATEGIES

As students design, manipulate, and construct increasingly complex systems to improve efficiency and performance, they can demonstrate their knowledge of energy sources and conversions and safety precautions and regulations.

- While students are constructing a high-mileage vehicle, look for evidence that they are able to:
  - determine ways in which more than one energy source can be used to control various aspects of the vehicle
  - explore the use of pneumatic and hydraulic control systems as well as mechanical control systems in order to achieve the most efficient control possible
  - practise hand and machine operations in order to achieve a high degree of fit and finish
  - consider the safety aspects of the control systems used in their vehicle and demonstrate abilities to modify or create new safety systems
- Ask students to prepare brief reports on the use of wind as an energy source and to compare it to other power production methods. Both pros and cons must be considered. In assessing their reports, look for evidence that they are able to:
  - identify a number of pros and cons
  - provide complete and accurate information
  - include numerical data
- Have students decide on criteria they can use for peer assessment of their remote door opener designs. Criteria might include:
  - incorporates electrical, hydraulic, or pneumatic actuators
  - meets the end-user's needs
  - is innovative in design
  - works safely and effectively
  - constructed to commercial-quality level

RECOMMENDED LEARNING RESOURCES

Print Materials

- Auto Electricity and Electronics Technology
- Design and Plastics
- Electrical/Electronic Systems
- Tracktronics

Video

- Air Transportation
- Cars
- Ecological Design
- Energy Choices
- Fluid Power Technology
- Fluid Power Technology at Work
- Fundamentals of Aeronautics Technology
- How Airplanes Work
- Inside Combustible Engines
- Introduction to Fluid Power
- Sea Transportation
- Technology for the Disabled

Multimedia

- Lasy Control 10 Day Module
- Orientation to WHMIS

Games/Manipulatives

- The Building Box: Model #2
- Digital Electronics Kit

CD-ROM

- Mitchell...Estimating System
- Mitchell...Repair Information System

APPENDICES

Technology Education 11 and 12

Appendix A

Prescribed Learning Outcomes

Grade 11

▶ **DESIGN AND COMMUNICATION** *(Principles and Concepts of Technology)*	*It is expected that students will:* • describe aesthetic and functional purposes for design elements (line, shape, form, colour, texture) in product and system designs • describe how product and system designs are influenced by specifications such as: - industry standards - function - availability of resources - user requirements • evaluate the effect of a variety of processes, tools, and techniques used to plan, research, and communicate design information and production details • describe the effect of technological change on postsecondary and career opportunities in the field of design and production
▶ **DESIGN AND COMMUNICATION** *(Problem Solving)*	*It is expected that students will:* • solve design problems using a variety of strategies • assess the appropriateness of design solutions • demonstrate ability to collaborate to analyse and solve design and communication problems
▶ **DESIGN AND COMMUNICATION** *(Modification and Manipulation)*	*It is expected that students will:* • develop and present design solutions using: - manual and computer drafting - prototypes and models - multimedia - computer animation or simulation • interpret and create accurate design representations • select and use materials and components in designs to reflect specific design criteria and community standards • apply concepts from other disciplines to the design process

Grade 11	
▶ **PRODUCT DEVELOPMENT** *(Principles and Concepts of Technology)*	*It is expected that students will:* • describe processes and components involved in manufacturing and production • compare the characteristics and properties of materials used to manufacture or produce products or systems • describe the forces that act on structures that must be taken into account when designing, manufacturing, or producing products or systems, including: - stress - static and dynamic loads • identify impacts of production and manufacturing processes on society and the environment • identify entrepreneurial opportunities in production and manufacturing
▶ **PRODUCT DEVELOPMENT** *(Problem Solving)*	*It is expected that students will:* • analyse the effect of design elements in a production process, based on the following factors: - principles of engineering - standards of quality and reliability - reduction of waste • communicate solutions to problems encountered in product development • demonstrate an understanding of the steps involved in managing product development projects
▶ **PRODUCT DEVELOPMENT** *(Modification and Manipulation)*	*It is expected that students will:* • produce finished products or systems from plans or designs (drawings, plans, schematics) • apply the processes of combining, forming, separating, and finishing • develop and modify products or systems to address: - principles of engineering - standards of quality and reliability - waste reduction - specified design criteria (form, function, aesthetics, ergonomics, end-user needs) • apply safe work habits in accordance with established regulations, including WCB and WHMIS regulations

Grade 11	
► **SYSTEMS INTEGRATION** *(Principles and Concepts of Technology)*	*It is expected that students will:* • summarize developments in computer and microelectronics technology related to systems integration, including: - electrical - electronic - pneumatic - hydraulic - mechanical • demonstrate an understanding of the application of computer control, including characteristics and configurations • describe the performance of systems and subsystems in terms of input, process, and output • describe the functions of analogue and digital components
► **SYSTEMS INTEGRATION** *(Problem Solving)*	*It is expected that students will:* • assess the performance of systems and subsystems using test equipment and prescribed procedures • justify solutions to systems integration problems • demonstrate personal responsibility in group efforts to identify and solve systems integration problems
► **SYSTEMS INTEGRATION** *(Modification and Manipulation)*	*It is expected that students will:* • use computer systems to control machines or devices • select and use a variety of input and output devices to achieve specific purposes • construct control systems or robotics devices that connect components, including: - controller - manipulator - end effector • design and construct electronic systems to recognized community standards that incorporate electronic components and development processes

Grade 11	
▶ **ENERGY, POWER, AND TRANSPORTATION** *(Principles and Concepts of Technology)*	*It is expected that students will:* • compare ways of using emerging and alternative energy sources to power mechanical devices • describe the relationship between potential and kinetic energy in making a mechanism function • demonstrate an understanding of the principles of hydraulics and pneumatics used to transmit energy • describe workplace applications in which technicians measure, control, convert, and transmit energy in various systems • describe the impact of energy, power, and transportation systems on society and the environment
▶ **ENERGY, POWER, AND TRANSPORTATION** *(Problem Solving)*	*It is expected that students will:* • measure the efficiency and performance of systems that use contemporary energy sources • perform test procedures on computer-equipped energy systems and communicate results • diagnose and repair problems in electrical and mechanical devices and systems • apply teamwork skills to solve problems involving mechanical systems and subsystems
▶ **ENERGY, POWER, AND TRANSPORTATION** *(Modification and Manipulation)*	*It is expected that students will:* • transfer and convert energy to achieve specific objectives • manipulate systems and subsystems that use energy and power, including: - mechanical - hydraulic - electrical - electronic • use tools and equipment accurately and efficiently to achieve design and assembly specifications that meet manufacturer and industry standards • construct a device or system that is energy efficient

Grade 12	
▶ **DESIGN AND COMMUNICATION** *(Principles and Concepts of Technology)*	*It is expected that students will:* • describe relationships among design elements (balance, rhythm, contrast, harmony, proportion, scale) • describe representation and modelling techniques used to develop design solutions, proposals, and plans • synthesize knowledge and concepts from other disciplines and the community in the design process • assess how design reflects society, culture, and the environment
▶ **DESIGN AND COMMUNICATION** *(Problem Solving)*	*It is expected that students will:* • assess and modify designs using specific criteria, including: - aesthetic factors - ergonomic factors - cost-effectiveness - available resources - environmental impact • apply project-management processes while working on design teams
▶ **DESIGN AND COMMUNICATION** *(Modification and Manipulation)*	*It is expected that students will:* • design products and systems and select appropriate materials and components to reflect specified design criteria, including: - method of production - cost - aesthetics - function - environmental considerations • use appropriate tools and equipment to develop and present design ideas, including: - manual drafting - CADD - computer animation or simulation - video and audio production - models • produce working drawings that incorporate recognized standards

Grade 12	
▶ **PRODUCT DEVELOPMENT** *(Principles and Concepts of Technology)*	*It is expected that students will:* • evaluate the effects of natural and synthetic materials on the properties, characteristics, and commercial uses of products • compare computer-assisted production processes (CADD, CAM, CNC, robotics) and assembly-line processes in terms of: - efficiency and cost-effectiveness - impact on product specifications - impact on society • describe a product or system in terms of its characteristics, including: - equilibrium (internal and external forces) - compression - tension - torsion - shear • assess how social, economic, and environmental conditions influence the choice of tools, manufacturing, and production processes used in developing products or systems • analyse how choices made during the development of products or systems reflect predetermined criteria, including: - aesthetics - environmental considerations - ergonomics - cost-effectiveness - function
▶ **PRODUCT DEVELOPMENT** *(Problem Solving)*	*It is expected that students will:* • appraise products or systems and justify modifications to design or production processes • use appropriate technical vocabulary and information technology tools to communicate solutions • apply business and entrepreneurship principles when developing products or systems

Grade 12	
► **PRODUCT DEVELOPMENT** *(Modification and Manipulation)*	*It is expected that students will:* • interpret design representations (drawings, plans, schematics) to assist in developing a product or system • use computer programs (including CADD, CAM, CNC) to assist in production and manufacturing processes • apply appropriate production processes (combining, forming, separating, finishing) to create products and systems that conform to: - specified design criteria (form, function, aesthetics, ergonomics, end-user needs) - recognized standards, conventions, and tolerances • apply the principles of WCB and WHMIS regulations in their work environment
► **SYSTEMS INTEGRATION** *(Principles and Concepts of Technology)*	*It is expected that students will:* • explain basic digital logic • explain how feedback is used to correct the functioning of systems and subsystems • describe systems integration that combines two or more of the following components: - electrical - electronic - pneumatic - hydraulic - mechanical
► **SYSTEMS INTEGRATION** *(Problem Solving)*	*It is expected that students will:* • analyse and solve problems related to the performance of systems and subsystems • communicate diagnostic information when solving systems and subsystems problems • demonstrate teamwork skills in group problem-solving situations
► **SYSTEMS INTEGRATION** *(Modification and Manipulation)*	*It is expected that students will:* • use sensing devices for feedback in a system or subsystem • design and construct products that integrate electronic, electrical, pneumatic, hydraulic, and mechanical systems and subsystems, and that meet industry standards • develop and apply codes for controlling robotics systems

Grade 12	
► **ENERGY, POWER, AND TRANSPORTATION** *(Principles and Concepts of Technology)*	*It is expected that students will:* • describe how types of motion (linear, rotary, oscillatory, reciprocating) are integrated in mechanical systems • explain the transfer and conversion of energy in devices and systems • describe ways to integrate emerging and alternative energy sources to power mechanical devices • apply the principles of kinematics to analyse how mechanisms function • evaluate social, economic, and environmental conditions that affect the selection of transportation systems
► **ENERGY, POWER, AND TRANSPORTATION** *(Problem Solving)*	*It is expected that students will:* • modify transportation devices and power systems to improve performance or efficiency • justify strategies and processes used to troubleshoot and diagnose problems • develop models to test or interpret the action of mechanical devices • demonstrate ability to work co-operatively in diagnostic teams
► **ENERGY, POWER, AND TRANSPORTATION** *(Modification and Manipulation)*	*It is expected that students will:* • design and construct devices and systems that use one or more energy sources (traditional and alternative) to achieve a measurable outcome • design and construct electrical, hydraulic, or pneumatic control systems that convert or transmit energy and power • construct devices and systems that reflect design criteria and industry standards

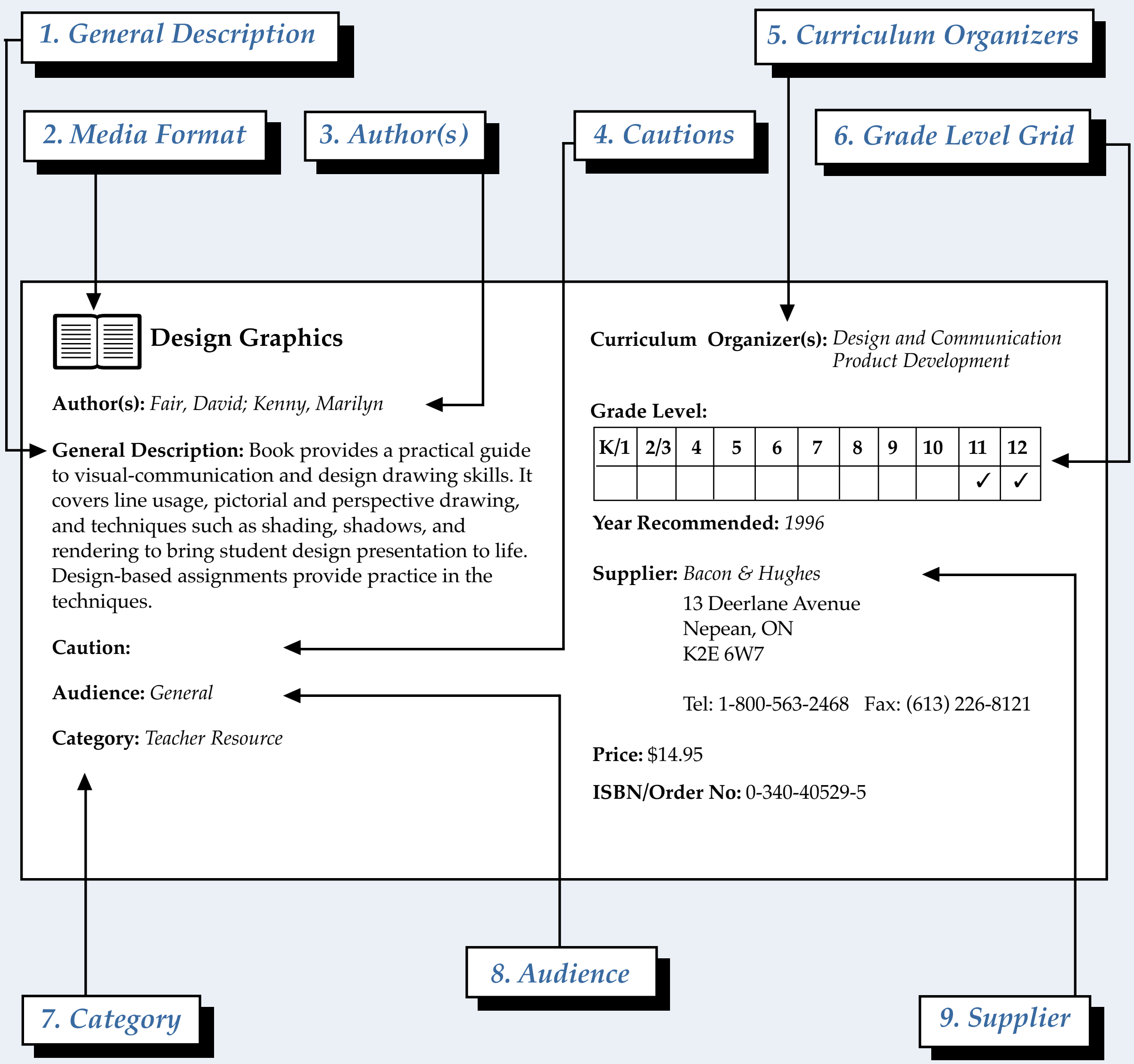
Appendix B

Learning Resources

WHAT IS APPENDIX B?

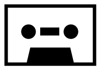
Appendix B is a comprehensive list of the *recommended* learning resources for Industrial Design 11 and 12. The titles are listed alphabetically and each resource is annotated. In addition, Appendix B contains information on selecting learning resources for the classroom.

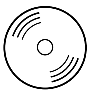
What information does an annotation provide?

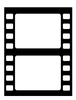


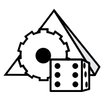
1. *General Description:* This section provides an overview of the resource.

2. *Media Format:* This part is represented by an icon next to the title. Possible icons include:

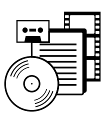

Audio Cassette


CD-ROM

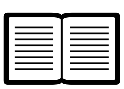

Film


Games/Manipulatives

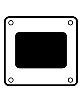

Laserdisc/Videodisc

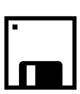

Multimedia

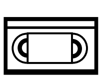

Music CD


Print Materials


Record


Slides


Software


Video

3. *Author(s):* Author or editor information is provided where it might be of use to the teacher.

4. *Cautions:* This category is used to alert teachers about potentially sensitive issues.

5. *Curriculum Organizers:* This category helps teachers make links between the resource and the curriculum.

6. *Grade Level Grid:* This category indicates the suitable age range for the resource.

7. *Category:* This section indicates whether it is a student and teacher resource, teacher resource, or professional reference.

8. *Audience:* This category indicates the suitability of the resource for different types of students. Possible student audiences include the following:
   - general
   - English as a second language (ESL)
   - *Students who are:*
     - gifted
     - blind or have visual impairments
     - deaf or hard of hearing
   - *Students with:*
     - severe behavioural disorders
     - dependent handicaps
     - physical disabilities
     - autism
     - learning disabilities (LD)
     - mild intellectual disabilities (ID-mild)
     - moderate to severe/profound disabilities (ID-moderate to severe/profound)

9. *Supplier:* The name and address of the supplier are included in this category. Prices shown here are approximate and subject to change. Prices should be verified with the supplier.

What about the videos?

The ministry attempts to obtain rights for most *recommended* videos. Negotiations for the most recently recommended videos may not be complete. For these titles, the original distributor is listed in this document, instead of British Columbia Learning Connection Inc. Rights for new listings take effect the year implementation begins. Please check with British Columbia Learning Connection Inc. before ordering new videos.

Selecting Learning Resources for the Classroom

Selecting a learning resource means choosing locally appropriate materials from the list of recommended resources or other lists of evaluated resources. The process of selection involves many of the same considerations as the process of evaluation, though not to the same level of detail. Content, instructional design, technical design, and social considerations may be included in the decision-making process, along with a number of other criteria.

The selection of learning resources should be an ongoing process to ensure a constant flow of new materials into the classroom. It is most effective as an exercise in group decision making, co-ordinated at the school, district, and ministry levels. To function efficiently and realize the maximum benefit from finite resources, the process should operate in conjunction with an overall district and school learning resource implementation plan.

Teachers may choose to use provincially recommended resources to support provincial or locally developed curricula; choose resources that are not on the ministry's list; or choose to develop their own resources. Resources that are not on the provincially recommended list must be evaluated through a local, board-approved process.

Criteria for Selection

There are a number of factors to consider when selecting learning resources.

Content

The foremost consideration for selection is the curriculum to be taught. Prospective resources must adequately support the particular learning outcomes that the teacher wants to address. Teachers will determine whether a resource will effectively support any given learning outcomes within a curriculum organizer. This can only be done by examining descriptive information regarding that resource; acquiring additional information about the material from the supplier, published reviews, or colleagues; and by examining the resource first-hand.

Instructional Design

When selecting learning resources, teachers must keep in mind the individual learning styles and abilities of their students, as well as anticipate the students they may have in the future. Resources have been recommended to support a variety of special audiences, including gifted, learning disabled, mildly intellectually disabled, and ESL students. The suitability of a resource for any of these audiences has been noted in the resource annotation. The instructional design of a resource includes the organization and presentation techniques; the methods used to introduce, develop, and summarize concepts; and the vocabulary level. The suitability of all of these should be considered for the intended audience.

Teachers should also consider their own teaching styles and select resources that will complement them. The list of *recommended* resources contains materials that range from prescriptive or self-contained resources, to open-ended resources that require considerable teacher preparation. There are *recommended* materials for teachers with varying levels of experience with a particular subject, as well as those that strongly support particular teaching styles.

Technology Considerations

Teachers are encouraged to embrace a variety of educational technologies in their classrooms. To do so, they will need to ensure the availability of the necessary equipment and familiarize themselves with its operation. If the equipment is not currently available, then the need must be incorporated into the school or district technology plan.

Social Considerations

All resources on the ministry's *recommended* list have been thoroughly screened for social concerns from a provincial perspective. However, teachers must consider the appropriateness of any resource from the perspective of the local community.

Media

When selecting resources, teachers should consider the advantages of various media. Some topics may be best taught using a specific medium. For example, video may be the most appropriate medium when teaching a particular, observable skill, since it provides a visual model that can be played over and over or viewed in slow motion for detailed analysis. Video can also bring otherwise unavailable experiences into the classroom and reveal "unseen worlds" to students. Software may be particularly useful when students are expected to develop critical-thinking skills through the manipulation of a simulation, or where safety or repetition is a factor. Print resources or CD-ROMs can best be used to provide extensive background information on a given topic. Once again, teachers must consider the needs of their individual students, some of whom may learn better from the use of one medium than another.

Funding

As part of the selection process, teachers should determine how much money is available to spend on learning resources. This requires an awareness of school and district policies, and procedures for learning resource funding. Teachers will need to know how funding is allocated in their district and how much is available for their needs. Learning resource selection should be viewed as an ongoing process that requires a determination of needs, as well as long-term planning to co-ordinate individual goals and local priorities.

Existing Materials

Prior to selecting and purchasing new learning resources, an inventory of those resources that are already available should be established through consultation with the school and district resource centres. In some districts, this can be facilitated through the use of district and school resource management and tracking systems. Such systems usually involve a database to help keep track of a multitude of titles. If such a system is available, then teachers can check the availability of a particular resource via a computer.

SELECTION TOOLS

The Ministry of Education, Skills and Training has developed a variety of tools to assist teachers with the selection of learning resources.

These include:

- Integrated Resource Packages (IRPs) that contain curriculum information, teaching and assessment strategies, and *recommended* learning resources
- resource databases on disks or on-line
- sets of the most recently recommended learning resources (provided each year to a number of host districts throughout the province to allow teachers to examine the materials first-hand at regional displays)
- sample sets of provincially recommended resources (available on loan to districts on request)

A MODEL SELECTION PROCESS

The following series of steps is one way a school resource committee might go about selecting learning resources:

1. Identify a resource co-ordinator (for example, a teacher-librarian).
2. Establish a learning resources committee made up of department heads or lead teachers.
3. Develop a school vision and approach to resource-based learning.
4. Identify existing learning resource and library materials, personnel, and infrastructure.
5. Identify the strengths and weaknesses of existing systems.
6. Examine the district Learning Resources Implementation Plan.
7. Identify resource priorities.
8. Apply criteria such as those found in *Evaluating, Selecting, and Managing Learning Resources: A Guide* to shortlist potential resources.
9. Examine shortlisted resources first-hand at a regional display or at a publishers' display, or borrow a set by contacting either a host district or the Curriculum and Resources Branch.
10. Make recommendations for purchase.

FURTHER INFORMATION

For further information on evaluation and selection processes, catalogues, annotation sets, or resource databases, please contact the Curriculum and Resources Branch of the Ministry of Education, Skills and Training.

Air Transportation

General Description: Part of *The Technology of Transportation Series*, this 15-minute video develops the scientific concepts behind the various modes of air transportation: airplane, helicopter, balloon, dirigible, and so on. Includes a historical look at their development, from military to freight and passenger crafts. Accompanying teacher's guide supports the series.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Magic Lantern Communications Ltd. (Ontario)*
Unit 38, 775 Pacific Road
Oakville, ON
L6L 6M4

Tel: 1-800-263-1717 Fax: (905) 827-1154

Price: $125.00

ISBN/Order No: Video: 1-3800001
Teacher's Guide: 0-7842-0789-5

Auto Electricity and Electronics Technology

Author(s): *Duffy, James E.*

General Description: Student text and accompanying workbook cover the following: electrical and electronic fundamentals; system construction and operation; systems diagnosis and repair; and reference. Text simplifies complex systems and procedures. Includes an instructor's guide that presents ideas for implementing an automotive technology program and provides answers to text and workbook questions.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Energy, Power, and Transportation*
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Irwin Publishing*
1800 Steeles Avenue West
Concord, ON
L4K 2P3

Tel: 1-800-387-0172 (orders only)
Fax: (905) 660-0676

Price: Text: $47.60
Workbook: $16.50
Instructor's Guide: $10.36

ISBN/Order No: Text: 1-56637-053-1
Workbook: 1-56637-054-X
Instructor's Guide: 1-56637-055-8

The Building Box: Model #2

Author(s): *Weiberg, Michele*

General Description: Construction kit with scaled lumber and materials, architectural plans, and instructions guides students through the process of constructing a residential home. Students read the blueprints, cut the materials, and assemble the model frame of the home to lock-up plus completion of the exterior. Materials required but not included are a glue gun, 1/2" plywood board 19" x 31" for the foundation of the house, X-acto knife or small coping saw, ruler or scale with 1" = 1', and pencils for marking. Requires the instructor to have some construction knowledge and skills.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Creative Education*
435 East 15th Street
North Vancouver, BC
V7L 2R9

Tel: (604) 983-3488 Fax: (604) 987-7399

Price: (not available)

ISBN/Order No: (not available)

Cars

General Description: Part of *The Technology of Transportation Series*, this 15-minute video covers the scientific concepts that have resulted in the development of the modern car. Includes a historical overview of the internal combustion engine and discusses the power train. Accompanying teacher's guide supports the series.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Magic Lantern Communications Ltd. (Ontario)*
Unit 38, 775 Pacific Road
Oakville, ON
L6L 6M4

Tel: 1-800-263-1717 Fax: (905) 827-1154

Price: $125.00

ISBN/Order No: Video: 1-3800003
Teacher's Guide: 0-7842-0789-5

Communication Systems

Author(s): *Johnson, Charles D.*

General Description: Student text introduces the various ways we use technology to communicate. It explores design and problem solving, drafting and CAD, photography, desktop publishing, electronic communication, and related careers. Includes a student activity manual with test items and an instructor's manual.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Product Development

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Irwin Publishing*
1800 Steeles Avenue West
Concord, ON
L4K 2P3

Tel: 1-800-387-0172 (orders only)
Fax: (905) 660-0676

Price: Text: $51.20
Instructor's Manual: $33.20
Student Activity Manual: $15.88

ISBN/Order No: Text: 0-87006-961-6
Instructor's Manual: 0-87006-963-2
Student Activity Manual: 0-87006-962-4

Design and Plastics

Author(s): *Hall, Mike*

General Description: Book illustrates the processes and procedures used in plastics technology. It covers the entire field of common plastics and demonstrates how they can be used in designing and making objects. Addresses such topics as forming, joining, machining, casting and lay-up, chemistry and structure, and safety.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Bacon & Hughes*
13 Deerlane Avenue
Nepean, ON
K2E 6W7

Tel: 1-800-563-2468 Fax: (613) 226-8121

Price: $19.95

ISBN/Order No: 0-340-40528-7

Design Graphics

Author(s): *Fair, David; Kenny, Marilyn*

General Description: Book provides a practical guide to visual-communication and design-drawing skills. It covers line usage, pictorial and perspective drawing, and techniques such as shading, shadows, and rendering to bring student design presentations to life. Design-based assignments provide practice in the techniques.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Product Development

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Bacon & Hughes*
13 Deerlane Avenue
Nepean, ON
K2E 6W7

Tel: 1-800-563-2468 Fax: (613) 226-8121

Price: $14.95

ISBN/Order No: 0-340-40529-5

Digital Electronics Kit

General Description: Manipulative kit containing six electronic modules with patch cords introduces basic digital electronics involving the three basic elements of input, process, and output. Accompanying manual for students and teachers contains activities to produce functional digital circuits, explores applications in digital electronics, and includes a teacher's guide. Requires a 6V battery not supplied in the kit.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Spectrum Educational Supplies Ltd.*
125 Mary St.
Aurora, ON
L4G 1G3

Tel: (905) 841-0600 Fax: (905) 727-6265

Price: $309.95

ISBN/Order No: 21633

Ecological Design: Inventing the Future

General Description: Sixty-four-minute video documents the design revolution inspired by Buckminster Fuller. It looks at the interface between design technology and the environment and addresses many of today's environmental concerns. Should stimulate students to study issues arising from overuse of technology and resources. Suggest viewing in segments, due to complexity of information.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Filmwest Associates Distribution Ltd.*
2399 Hayman Road
Kelowna, BC
V1Z 1Z7

Tel: (250) 769-3399 Fax: (250) 769-5599

Price: (not available)

ISBN/Order No: (not available)

Electrical/Electronic Systems

Author(s): *Mazur, Glen A.; Proctor, Thomas E.*

General Description: Book provides a comprehensive look at electrical/electronics systems including symbols and components, drawings, rotating and non-rotating outputs, control circuits, electrical/electronic interfaces, relays and transformers, plus protection and monitoring systems. Includes a student workbook, instructor's guide, and full-colour transparencies.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Gage Educational Publishing Co.*
7554 Haszard Street
Burnaby, BC
V5E 3X1

Tel: (604) 540-0509 Fax: (604) 540-0630

Price: (not available)

ISBN/Order No: (not available)

Energy Choices

General Description: Award-winning 43-minute video divided into four modules covers the following: a brief history of energy use and energy technology; energy and the environment; energy efficiency; renewables and other energy alternatives. Includes a teacher's guide with questions and activities.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Also Recommended For: *Science 8-10, Earth Science 11*

Supplier: *MediCinema Ltd.*
131 Albany Avenue
Toronto, ON
M5R 3C5

Tel: (416) 977-0569 Fax: (416) 977-0569

Price: (not available)

ISBN/Order No: 1-896415-06-7

Energy: Sources, Applications, Alternatives

Author(s): *Smith, Bud Howard*

General Description: Book covers topics such as energy, power, fuel sources, and alternative energy sources. Each chapter includes a list of objectives, summary, suggested activities, and test questions. Colour diagrams, pictures, and charts illustrate key concepts. Accompanying student workbook and instructor's manual have not been evaluated.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	

Year Recommended: *1996*

Also Recommended For: *Technology Education 8-10*

Supplier: *Irwin Publishing*
1800 Steeles Avenue West
Concord, ON
L4K 2P3

Tel: 1-800-387-0172 (orders only)
Fax: (905) 660-0676

Price: $44.00

ISBN/Order No: 0-87006-956-X

Fluid Power Technology: Actuators

Curriculum Organizer(s): *Energy, Power, and Transportation*
Product Development
Systems Integration

General Description: Twenty-four-minute video summarizes and discusses the various types of fluid power actuators used in industry, including hydraulic and pneumatic cylinders, motors, rotators, grippers, and other power output devices. Includes a user's guide with post-viewing activities.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Jeflyn Media Consultants*
4 Hidden Forest Drive
Cedar Valley, ON
L0G 1N0

Tel: 1-888-453-3596 Fax: (905) 473-1408

Price: $160.00

ISBN/Order No: (not available)

Fluid Power Technology at Work

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

General Description: Twenty-four-minute video teaches the principles of fluid power through the use of animation supplemented with real-world applications. It deals with hydraulic, pneumatic, and electronic machines used in industrial and commercial settings. Accompanying user's guide includes activities and answer key.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*
Also Recommended For: *Technology Education 8-10*

Supplier: *B.C. Learning Connection Inc.*
c/o Learning Resources Branch (Customer Service)
PO Box 1967 Stn Prov Govt
Victoria, BC
V8W 9H5

Tel: (250) 387-5331 Fax: (250) 387-1527

Price: $21.00

ISBN/Order No: TE0011

Fundamentals of Aeronautics Technology

Curriculum Organizer(s): *Energy, Power, and Transportation*
Product Development
Systems Integration

General Description: Fourteen-minute video demonstrates the theory and application of aeronautic principles in the flight of an airplane. It also explores the history of flight.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Jeflyn Media Consultants*
4 Hidden Forest Drive
Cedar Valley, ON
L0G 1N0

Tel: 1-888-453-3596 Fax: (905) 473-1408

Price: $130.00

ISBN/Order No: SW505H

How Airplanes Work

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development

General Description: Part of *The Technology of Transportation Series*, this 15-minute video develops the scientific concepts of the principles of flight. Format includes an overview of the design, construction, and operation of contemporary aircraft, from takeoff to landing. Accompanying teacher's guide supports the series.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Magic Lantern Communications Ltd. (Ontario)*
Unit 38, 775 Pacific Road
Oakville, ON
L6L 6M4

Tel: 1-800-263-1717 Fax: (905) 827-1154

Price: $125.00

ISBN/Order No: Video: 1-3800002
Teacher's Guide: 0-7842-0789-5

Industrial Design

General Description: Fourteen-minute video, featuring Jaime Escalante, links the real world with technology by interviewing professionals who discuss what they do and how technology is required for their work. Includes music, animation, and archival footage. Promotes positive attitudes toward technology in striving to achieve personal goals.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Product Development

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Also Recommended For: *Mathematics K-7, Mathematics 8-10*

Supplier: *Visual Education Centre Ltd.*
Unit 3, 41 Horner Avenue
Etobicoke, ON
M8Z 4X4

Tel: 1-800-668-0749 Fax: (416) 251-3720

Price: (not available)

ISBN/Order No: 0-7936-0844-9

Inside Combustible Engines

General Description: Part of *The Technology of Transportation Series*, this 15-minute video develops the scientific concepts behind the major types of combustion engines and includes a historical overview of internal and external combustion engines. Accompanying teacher's guide supports the series.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Magic Lantern Communications Ltd. (Ontario)*
Unit 38, 775 Pacific Road
Oakville, ON
L6L 6M4

Tel: 1-800-263-1717 Fax: (905) 827-1154

Price: $125.00

ISBN/Order No: Video: 1-3800004
Teacher's Guide: 0-7842-0789-5

Introduction to Fluid Power, Fluid Power Actuators, Fluid Power Technology at Work

General Description: Series of three videos, ranging from 19-24 minutes, provides real-world industrial examples of fluid-power systems. They explain principles, describe basic operation, and present applications of fluid-power technology. Accompanying user's guide provides an overview, objectives, activities, and quizzes.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Also Recommended For: *Applied Physics 11, Applied Physics 12*

Supplier: *Jeflyn Media Consultants*
4 Hidden Forest Drive
Cedar Valley, ON
L0G 1N0

Tel: 1-888-453-3596 Fax: (905) 473-1408

Price: $160.00

ISBN/Order No: (not available)

Land Transportation

General Description: Part of *The Technology of Transportation Series*, this 15-minute video develops the scientific concepts from the discovery of the wheel to solar-powered vehicles and magnetic-levitation trains. Includes a historical overview of land transportation. Accompanying teacher's guide supports the series.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Magic Lantern Communications Ltd. (Ontario)*
Unit 38, 775 Pacific Road
Oakville, ON
L6L 6M4

Tel: 1-800-263-1717 Fax: (905) 827-1154

Price: $125.00

ISBN/Order No: Video: 1-3800006
Teacher's Guide: 0-7842-0789-5

Lasy Control 10 Day Module

Curriculum Organizer(s): *Energy, Power, and Transportation*
Product Development
Systems Integration

General Description: Ninety-five-piece starter kit comprises motors, gearboxes, lights, building blocks, electromagnets, buzzers, digital sensors, and so on. The computer interface module, including instruction and programming guide, allows students to design, build, and control a robotic manipulative. The 10 Day Module binder provides the activities to use with this program and includes pre- and post-tests and corresponding answer keys.

System requirements: MS-DOS 3.2 or later; VGA monitor; RS232-C serial port connector for the interface; mouse recommended.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Spectrum Educational Supplies Ltd.*
2102 Elspeth Place
Port Coquitlam, BC
V3C 1G3

Tel: (604) 942-5835 Fax: (604) 941-1066

Price: 10 Day Module Binder: $44.95
Starter Kit: $379.60
Lasy Control Software: $365.95

ISBN/Order No: 10 Day Module Binder: 20085
Starter Kit: 20082
Lasy Control Software: 20086

Mitchell Mechanical Parts and Labour Estimating System

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development

General Description: Resource creates a computerized system for repair-shop estimating. It provides parts prices, labour times, and maintenance schedules to allow accurate estimates and vehicle servicing. Package comprises two set-up disks, one CD-ROM for MS-DOS or Windows, and a program troubleshooting manual.

System requirements: DOS 5.0 or later; Windows 3.1x; 4 Mb RAM; VGA monitor; mouse; CD-ROM drive.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Mitchell International*
P.O. Box 50021, S0. R.P.O.
Burnaby, BC
V5J 4K0

Tel: (800) 648-8010 (orders) Fax: (604) 420-4109

Price: $331.00

ISBN/Order No: (not available)

Mitchell "On-Demand" Computerized Automotive Repair Information System

Curriculum Organizer(s): *Energy, Power, and Transportation*
Product Development
Systems Integration

General Description: Resource presents a complete system of diagnostic and repair information permitting quick access to information on import and domestic vehicles according to their make, model, and year. Package comprises two set-up disks, seven Windows CD-ROMs, and a program instruction and troubleshooting manual.

System requirements: Windows 3.1, 8 Mb RAM, CD-ROM drive, VGA monitor.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Mitchell International*
P.O. Box 50021, S0. R.P.O.
Burnaby, BC
V5J 4K0

Tel: (800) 648-8010 (orders) Fax: (604) 420-4109

Price: $2695.00

ISBN/Order No: (not available)

The New Digital Imaging

Curriculum Organizer(s): *Design and Communication*

General Description: Using interviews, graphics, and product demonstration, this 20-minute video presents advances in digital imaging in the field of technology, and the proliferation of technology in this area. It covers cameras, scan devices, storage, transmission, and so on in eight sections. Highlights ethical issues of manipulation.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Also Recommended For: *Multimedia and Technology 11/12*

Supplier: *B.C. Learning Connection Inc.*
c/o Learning Resources Branch (Customer Service)
PO Box 1967 Stn Prov Govt
Victoria, BC
V8W 9H5

Tel: (250) 387-5331 Fax: (250) 387-1527

Price: $20.00

ISBN/Order No: VA0041

The New Product Development Program

Curriculum Organizer(s): *Design and Communication*
Product Development

Author(s): *Boadway, Michael*

General Description: Binder is a step-by-step guide to the different stages in the inventing process - from the initial idea to making a profit. It comprises the following four sections: product knowledge, product checklists, product samples, and product logbook.

Audience: *General*

Category: *Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Copp Clark Ltd.*
2775 Matheson Boulevard East
Mississauga, ON
L4W 4P7

Tel: 1-800-263-4374 Fax: (905) 238-6075

Price: $99.95

ISBN/Order No: 0-7730-5518-5

Orientation to WHMIS

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

General Description: Interactive, computer-based training program comprises two installation disks, one management disk, and a training manager's guide. It provides a student/employee training program in WHMIS. Includes a post-test and certification process that may enhance a student's employment portfolio.

System requirements: MS-DOS system 5.0 or later; 1 Mb RAM; mouse required. Windows and Novell formats have not been evaluated.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Knowledgeware Communications Corp.*
102 - 145 West 15th Street
North Vancouver, BC
V7M 1R9

Tel: (604) 988-7157 Fax: (604) 988-7156

Price: $199.00

ISBN/Order No: OTW

Project Design: A Teacher's Manual for Broad-base Technology Courses

Curriculum Organizer(s): *Design and Communication*
Product Development

Author(s): *Loney, D.E.*

General Description: Binder focusses on the design process. It develops the analytical, creative, emotional, social, moral, and operational abilities of students through their involvement in a structured group process that is project driven. Includes specific teaching suggestions, blackline masters, and evaluation strategies.

Audience: *General*

Category: *Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Prentice Hall Ginn Canada (Ont.)*
1870 Birchmount Road
Scarborough, ON
M1P 2J7

Tel: 1-800-567-3800 Fax: (416) 299-2539

Price: $143.50

ISBN/Order No: 0-13-442179-5

Sea Transportation

General Description: Part of *The Technology of Transportation Series*, this 14-minute video develops the scientific concepts of buoyancy, sails, sailing, and engines that propel vessels. It includes a historical look at sea transportation. Accompanying teacher's guide supports the series.

Audience: *General*

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Magic Lantern Communications Ltd. (Ontario)*
Unit 38, 775 Pacific Road
Oakville, ON
L6L 6M4

Tel: 1-800-263-1717 Fax: (905) 827-1154

Price: $125.00

ISBN/Order No: Video: 95-31-380000
Teacher's Guide: 0-7842-0789-5

Technology for the Disabled

General Description: Twenty-eight-minute video deals with the technology that has been developed and refined to improve the independence and quality of life for mildly and severely physically handicapped people. It gives numerous examples of technological breakthroughs and innovations.

Audience: *General*
Special Needs - deals with innovations through the use of computer technology to improve the quality of life for the physically handicapped

Category: *Student, Teacher Resource*

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Omega Films Ltd.*
1581 Longwood Road
Cowichan Bay, BC
V0R 1N0

Tel: (604) 746-8663

Price: (not available)

ISBN/Order No: 8-1006

Tracktronics: Circuit Masters

Curriculum Organizer(s): *Design and Communication*
Energy, Power, and Transportation
Product Development
Systems Integration

Author(s): *Taylor, Richard; Toner, Will*

General Description: Book provides a simple method of producing electronic circuits with self-adhesive copper track laid directly on a circuit layout using a few basic tools and a soldering pen. Part 1 introduces the program; Part 2 contains 55 electronic circuits for students to build.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Spectrum Educational Supplies Ltd.*
2102 Elspeth Place
Port Coquitlam, BC
V3C 1G3

Tel: (604) 942-5835 Fax: (604) 941-1066

Price: $79.95

ISBN/Order No: 1-873-10-1171/21669

Welcome to...Macintosh Multimedia

Curriculum Organizer(s): *Design and Communication*

Author(s): *Neuschotz, Nilson*

General Description: Book with supporting Macintosh CD-ROM provides an easy-to-read introduction to multimedia for the Macintosh. Interactive CD-ROM has save-disabled versions of the following: Adobe Illustrator, Photoshop, Premiere, Macromedia Director, Strata, StudioPro, and Fractal Design Painter.

System requirements: System 7.0 or later; 5 Mb RAM; QuickTime; CD-ROM drive.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Fitzhenry & Whiteside Ltd.*
195 Allstate Parkway
Markham, ON
L3R 4T8

Tel: 1-800-387-9776 Fax: (905) 477-9179

Price: $38.95

ISBN/Order No: 1-55828-3390

Welcome to...PC Sound, Music, and MIDI

Curriculum Organizer(s): *Design and Communication*
Product Development
Systems Integration

Author(s): *Benford, Tom*

General Description: Book with supporting Windows CD-ROM provides a thorough explanation of how sound is processed by a computer, a comparison of FM versus wavetable sound synthesis, and reviews of over 75 hardware and software products. CD-ROM contains MIDI music files, WAV sound-effects files, and eight audiotracks.

System requirements: System 3.1; VGA monitor, sound card, CD-ROM drive; mouse.

Audience: *General*

Category: *Student, Teacher Resource*

Grade Level:

K/1	2/3	4	5	6	7	8	9	10	11	12
									✓	✓

Year Recommended: *1996*

Supplier: *Fitzhenry & Whiteside Ltd.*
195 Allstate Parkway
Markham, ON
L3R 4T8

Tel: 1-800-387-9776 Fax: (905) 477-9179

Price: $27.95

ISBN/Order No: 1-55828-3161

Appendix C

Cross-Curricular Interests

The three principles of learning stated in the introduction of this Integrated Resource Package (IRP) support the foundation of The Kindergarten to Grade 12 Education Plan. They have guided all aspects of the development of this document, including the curriculum outcomes, instructional strategies, assessment strategies, and learning resource evaluations.

In addition to these three principles, the Ministry of Education, Skills and Training wants to ensure that education in British Columbia is relevant, equitable, and accessible to all learners. In order to meet the needs of all learners, the development of each component of this document has been guided by a series of cross-curricular reviews. This appendix outlines the key aspects of each of these reviews. The information here is intended to guide the users of this document as they engage in school and classroom organization and instructional planning and practice.

The areas of cross-curricular interest are:

- Applied Focus in Curriculum
- Career Development
- English as a Second Language (ESL)
- Environment and Sustainability
- Aboriginal Studies
- Gender Equity
- Information Technology
- Media Education
- Multiculturalism and Anti-Racism
- Science-Technology-Society
- Special Needs

Applied Focus in Curriculum

An applied focus combines the following components in curriculum development, consistent with the nature of each subject area:

Learning Outcomes—expressed as observable, measurable, and reportable abilities or skills

Employability Skills—inclusion of outcomes or strategies that promote skills that will enable students to be successful in the workplace (e.g., literacy, numeracy, critical and creative thinking, problem solving, technology, and information management)

Contextual Learning—an emphasis on learning by doing; the use of abstract ideas and concepts, including theories, laws, principles, formulae, rules, or proofs in a practical context (e.g., home, workplace, community)

Interpersonal Skills—inclusion of strategies that promote co-operative activities and teamwork

Career Development—inclusion of appropriate connections to careers, occupations, entrepreneurship, or the workplace

An applied focus in all subjects and courses promotes the use of practical applications to demonstrate theoretical knowledge. Using real-world and workplace problems and situations as a context for the application of theory makes school more relevant to students' needs and goals. An applied focus strengthens the link between what students need to know to function effectively in the workplace or in postsecondary education and what they learn in Kindergarten through Grade 12.

Some examples of an applied focus in different subjects are:

English Language Arts—increasing emphasis on language used in everyday situations and in the workplace, such as for job interviews, memo and letter writing, word processing, and technical communications (including the ability to interpret technical reports, manuals, tables, charts, and graphics)

Mathematics—more emphasis on skills needed in the workplace, including knowledge of probability and statistics, logic, measurement theory, and problem solving

Science—more practical applications and hands-on experience of science, such as reducing energy waste in school or at home, caring for a plant or animal in the classroom, and using computers to produce tables and graphs and for spreadsheets

Business Education—more emphasis on real-world applications such as preparing résumés and personal portfolios, participating in groups to solve business communication problems, using computer software to keep records, and using technology to create and print marketing material

Visual Arts—applying visual arts skills to real-world design, problem solving, and communications; exploring career applications of visual arts skills; experimenting with a variety of new technologies to create images; and a new emphasis on creating and understanding images of social significance to the community

This summary is derived from *The Kindergarten to Grade 12 Education Plan* (September 1994), and curriculum documents from British Columbia and other jurisdictions.

CAREER DEVELOPMENT

Career development is an ongoing process through which learners integrate their personal, family, school, work, and community experiences to facilitate career and lifestyle choices.

Students develop:

- an open attitude toward a variety of occupations and types of work
- an understanding of the relationship between work and leisure, work and the family, and work and one's interests and abilities
- an understanding of the role of technology in the workplace and in daily life
- an understanding of the relationship between work and learning
- an understanding of the changes taking place in the economy, society, and the job market
- an ability to construct learning plans and reflect on the importance of lifelong learning
- an ability to prepare for multiple roles throughout life

The main emphases of career development are career awareness, career exploration, career preparation, career planning, and career work experience.

In the Primary Years

Career awareness promotes an open attitude toward a variety of career roles and types of work. Topics include:

- the role of work and leisure
- relationships among work, the family, one's personal interests, and one's abilities

A variety of careers can be highlighted through the use of in-class learning activities that focus on the students themselves and on a range of role models, including non-traditional role models.

In Grades 4 to 8

The emphasis on self-awareness and career awareness is continued. Topics include:

- interests, aptitudes, and possible future goals
- technology in the workplace and in our daily lives
- social, family, and economic changes
- future education options
- career clusters (careers that are related to one another)
- lifestyles
- external influences on decision making

Games, role-playing, drama, and appropriate community volunteer experience can be used to help students actively explore the world of work. Field experiences in which students observe and interview workers in their occupational environments may also be appropriate. These learning activities will facilitate the development of interpersonal communications and group problem-solving skills needed in the workplace and in other life situations.

In Grades 9 and 10

The emphasis is on providing students with opportunities to prepare for and make appropriate and realistic decisions. In developing their student learning plans, they will relate self-awareness to their goals and aspirations. They will also learn many basic skills and attitudes that are required for an effective transition into adulthood. This will assist in preparing them to be responsible and self-directed throughout their lives. Topics include:

- entrepreneurial education
- employability skills (e.g., how to find and keep a job)
- the importance of lifelong education and career planning
- involvement in the community
- the many different roles that an individual can play throughout life
- the dynamics of the working world (e.g., unions, unemployment, supply and demand, Pacific Rim, free trade)

The examination of personal interests and skills through a variety of career exploration opportunities (e.g., job shadowing) is emphasized at this level. Group discussion and individual consultation can be used to help students examine and confirm their personal values and beliefs.

In Grades 11 and 12

Career development in these grades is focussed more specifically on issues related to the world of work. These include:

- dynamics of the changing work force and changing influences on the job market (e.g., developing technology and economic trends)
- job-keeping and advancement skills (interpersonal skills needed in the workplace, employment standards)
- occupational health issues and accessing health support services
- funding for further education
- alternative learning strategies and environments for different life stages
- mandatory work experience (minimum 30 hours)

Work Experience

Work experience provides students with opportunities to participate in a variety of workplace situations to help prepare them for the transition to a work environment. Work experience also provides students with opportunities to:

- connect what they learn in school with the skills and knowledge needed in the workplace and society in general
- experience both theoretical and applied learning, which is part of a broad liberal education
- explore career directions identified in their Student Learning Plans

Descriptions of career development are drawn from the ministry's *Career Developer's Handbook, Guidelines for the Kindergarten to Grade 12 Education Plan, Implementation Resource, Part 1*, and the *Career and Personal Planning 8 to 12 IRP* (1997).

ENGLISH AS A SECOND LANGUAGE (ESL)

ESL assistance is provided to students whose use of English is sufficiently different from standard English to prevent them from reaching their potential. Many students learning English speak it quite fluently and seem to be proficient. School, however, demands a more sophisticated version of English, both in reading and writing. Thus even fluent speakers might require ESL to provide them with an appropriate language experience that is unavailable outside the classroom. ESL is a transitional service rather than a subject. Students are in the process of learning the language of instruction and, in many cases, the content matter of subjects appropriate to their grade level. Thus ESL does not have a specific curriculum. The provincial curriculum is the basis of much of the instruction and is used to teach English as well as individual subject areas. It is the methodology, the focus, and the level of engagement with the curriculum that differentiates ESL services from other school activities.

Students in ESL

Nearly 10% of the British Columbia school population is designated as ESL students. These students come from a diversity of backgrounds. Most are recent immigrants to British Columbia. Some are Canadian-born but have not had the opportunity to learn English before entering the primary grades. The majority of ESL students have a well-developed language system and have had similar schooling to that of British Columbia-educated students. A small number, because of previous experiences, are in need of basic support such as literacy training, academic upgrading, and trauma counselling.

Teachers may have ESL students at any level in their classes. Many ESL students are placed in subject-area classes primarily for the purpose of contact with English-speaking peers and experience with the subject and language. Other ESL students are wholly integrated into subject areas. A successful integration takes place when the student has reached a level of English proficiency and background knowledge in a subject to be successful with a minimum of extra support.

Optimum Learning Environment

The guiding principle for ESL support is the provision of a learning environment where the language and concepts can be understood by students.

Good practices to enhance learning include:

- using real objects and simple language at the beginning level
- taking into consideration other cultural backgrounds and learning styles at any level
- providing adapted (language-reduced) learning materials
- respecting a student's "silent period" when expression does not reflect the level of comprehension
- allowing students to practise and internalize information before giving detailed answers
- differentiating between form and content in student writing
- keeping in mind the level of demand placed on students

This summary is drawn from *Supporting Learners of English: Information for School and District Administrators*, RB0032, 1993, and *ESL Policy Discussion Paper (Draft)*, Social Equity Branch, December 1994.

Environment and Sustainability

Environmental education is defined as a way of understanding how humans are part of and influence the environment. It involves:

- students learning about their connections to the natural environment through all subjects
- students having direct experiences in the environment, both natural and human-built
- students making decisions about and acting for the environment

The term *sustainability* helps to describe societies that "promote diversity and do not compromise the natural world for any species in the future."

Value of Integrating Environment and Sustainability Themes

Integrating "environment and sustainability" themes into the curriculum helps students develop a responsible attitude toward caring for the earth. Students are provided with opportunities to identify their beliefs and opinions, reflect on a range of views, and ultimately make informed and responsible choices.

Some guiding principles that support the integration of "environment and sustainability" themes in subjects from Kindergarten to Grade 12 include:

- Direct experience is the basis of learning.
- Responsible action is integral to, and a consequence of, environmental education.
- Life on Earth depends on, and is part of, complex systems.
- Human decisions and actions have environmental consequences.
- Environmental awareness enables students to develop an aesthetic appreciation of the environment.
- The study of the environment enables students to develop an environmental ethic.

This summary is derived from *Environmental Concepts in the Classroom: A Guide for Teachers,* Ministry of Education, 1995.

Aboriginal Studies

Aboriginal studies focus on the richness and diversity of Aboriginal cultures and languages. These cultures and languages are examined within their own unique contexts and within historical, contemporary, and future realities. Aboriginal studies are based on a holistic perspective that integrates the past, present, and future. Aboriginal peoples are the original inhabitants of North America and live in sophisticated, organized, and self-sufficient societies. The First Nations constitute a cultural mosaic as rich and diverse as that of Western Europe, including different cultural groups (e.g., Nisga'a, KwaKwaka'Wakw, Nlaka'pamux, Secwepemc, Skomish, Tsimshian). Each is unique and has a reason to be featured in the school system. The First Nations of British Columbia constitute an important part of the historical and contemporary fabric of the province.

Value of Integrating Aboriginal Studies

- First Nations values and beliefs are durable and relevant today.
- There is a need to validate and substantiate First Nations identity.
- First Nations peoples have strong, dynamic, and evolving cultures that have adapted to changing world events and trends.
- There is a need to understand similarities and differences among cultures to create tolerance, acceptance, and mutual respect.

- There is a need for informed, reasonable discussion and decision making regarding First Nations issues, based on accurate information (for example, as modern treaties are negotiated by Canada, British Columbia, and First Nations).

In studying First Nations, it is expected that students will:

- demonstrate an understanding and appreciation for the values, customs, and traditions of First Nations peoples
- demonstrate an understanding of and appreciation for unique First Nations communications systems
- demonstrate a recognition of the importance of the relationship between First Nations peoples and the natural world
- recognize dimensions of First Nations art as a total cultural expression
- give examples of the diversity and functioning of the social, economic, and political systems of First Nations peoples in traditional and contemporary contexts
- describe the evolution of human rights and freedoms as they pertain to First Nations peoples

Some examples of curriculum integration include:

Visual Arts—comparing the artistic styles of two or more First Nations cultures

English Language Arts—analysing portrayals and images of First Nations peoples in various works of literature

Home Economics—identifying forms of food, clothing, and shelter in past and contemporary First Nations cultures

Technology Education—describing the sophistication of traditional First Nations technologies (e.g., bentwood or kerfed boxes, weaving, fishing gear)

Physical Education—participating in and developing an appreciation for First Nations games and dances

This summary is derived from *First Nations Studies: Curriculum Assessment Framework (Primary Through Graduation)*, Aboriginal Education Branch, 1992, and *B.C. First Nations Studies 12 Curriculum*, Aboriginal Education Branch, 1994.

GENDER EQUITY

Gender-equitable education involves the inclusion of the experiences, perceptions, and perspectives of girls and women, as well as boys and men, in all aspects of education. It will initially focus on girls in order to redress historical inequities. Generally, the inclusive strategies, which promote the participation of girls, also reach boys who are excluded by more traditional teaching styles and curriculum content.

Principles of Gender Equity in Education

- All students have the right to a learning environment that is gender equitable.
- All education programs and career decisions should be based on a student's interest and ability, regardless of gender.
- Gender equity incorporates a consideration of social class, culture, ethnicity, religion, sexual orientation, and age.
- Gender equity requires sensitivity, determination, commitment, and vigilance over time.
- The foundation of gender equity is co-operation and collaboration among students, educators, education organizations, families, and members of communities.

General Strategies for Gender-Equitable Teaching

- Be committed to learning about and practising equitable teaching.
- Use gender-specific terms to market opportunities—for example, if a technology fair has been designed to appeal to girls, mention girls clearly and specifically. Many girls assume that gender-neutral language in non-traditional fields means boys.
- Modify content, teaching style, and assessment practices to make non-traditional subjects more relevant and interesting for female and male students.
- Highlight the social aspects and usefulness of activities, skills, and knowledge.
- Comments received from female students suggest that they particularly enjoy integrative thinking; understanding context as well as facts; and exploring social, moral, and environmental impacts of decisions.
- When establishing relevance of material, consider the different interests and life experiences that girls and boys may have.
- Choose a variety of instructional strategies such as co-operative and collaborative work in small groups, opportunities for safe risk taking, hands-on work, and opportunities to integrate knowledge and skills (e.g., science and communication).
- Provide specific strategies, special opportunities, and resources to encourage students to excel in areas of study in which they are typically under-represented.
- Design lessons to explore many perspectives and to use different sources of information; refer to female and male experts.
- Manage competitiveness in the classroom, particularly in areas where male students typically excel.
- Watch for biasses (e.g., in behaviour or learning resources) and teach students strategies to recognize and work to eliminate inequities they observe.
- Be aware of accepted gender-bias practices in physical activity (e.g., in team sport, funding for athletes, and choices in physical education programs).
- Do not assume that all students are heterosexual.
- Share information and build a network of colleagues with a strong commitment to equity.
- Model non-biassed behaviour: use inclusive, parallel, or gender-sensitive language; question and coach male and female students with the same frequency, specificity, and depth; allow quiet students sufficient time to respond to questions.
- Have colleagues familiar with common gender biasses observe your teaching and discuss any potential bias they may observe.
- Be consistent over time.

This summary is derived from the preliminary *Report of the Gender Equity Advisory Committee*, received by the Ministry of Education in February 1994, and from a review of related material.

Information Technology

Information technology is the use of tools and electronic devices that allow us to create, explore, transform, and express information.

Value of Integrating Information Technology

As Canada moves from an agricultural and industrial economy to the information age, students must develop new knowledge, skills, and attitudes. The information technology curriculum has been developed to be integrated into all new curricula to ensure that students know how to use computers and gain the technological literacy demanded in the workplace.

In learning about information technology, students acquire skills in information analysis and evaluation, word processing, database analysis, information management, graphics, and multimedia applications. Students also identify ethical and social issues arising from the use of information technology.

With information technology integrated into the curriculum, students will be expected to:

- demonstrate basic skills in handling information technology tools
- demonstrate an understanding of information technology structure and concepts
- relate information technology to personal and social issues
- define a problem and develop strategies for solving it
- apply search criteria to locate or send information
- transfer information from external sources
- evaluate information for authenticity and relevance
- arrange information in different patterns to create new meaning
- modify, revise, and transform information
- apply principles of design affecting the appearance of information
- deliver a message to an audience using information technology

The curriculum organizers are:

- ***Foundations***—provides the basic physical skills and intellectual and personal understanding required to use information technology, as well as self-directed learning skills and socially responsible attitudes
- ***Process***—allows students to select, organize, and modify information to solve problems
- ***Presentation***—provides students with an understanding of how to communicate ideas effectively using a variety of information technology tools

This information is derived from the Information Technology K to 12 curriculum.

MEDIA EDUCATION

Media education is a multidisciplinary and interdisciplinary approach to the study of media. Media education deals with key media concepts and focusses on broad issues such as the history and role of media in different societies and the social, political, economic, and cultural issues related to the media. Instead of addressing the concepts in depth, as one would in media studies, media education deals with most of the central media concepts as they relate to a variety of subjects.

Value of Integrating Media Education

Popular music, TV, film, radio, magazines, computer games, and information services—all supplying media messages—are pervasive in the lives of students today. Media education develops students' abilities to think critically and independently about issues that affect them. Media education encourages students to identify and examine the values contained in media messages. It also cultivates the understanding that these messages are produced by others to inform, persuade, and entertain for a variety of purposes. Media education helps students understand the distortions that may result from the use of particular media practices and techniques.

All curriculum areas provide learning opportunities for media education. It is not taught as a separate curriculum.

The key themes of media education are:

- media products (purpose, values, representation, codes, conventions, characteristics, production)
- audience interpretation and influence (interpretation, influence of media on audience, influence of audience on media)
- media and society (control, scope)

Examples of curriculum integration include:

English Language Arts—critiquing advertising and examining viewpoints

Visual Arts—analysing the appeal of an image by age, gender, status, and other characteristics of the target audience

Personal Planning—examining the influence of the media on body concepts and healthy lifestyle choices

Drama—critically viewing professional and amateur theatre productions, dramatic films, and television programs to identify purpose

Social Studies—comparing the depiction of First Nations in the media over time

This summary is derived from *A Cross-Curricular Planning Guide for Media Education*, prepared by the Canadian Association for Media Education for the Curriculum Branch in 1994.

MULTICULTURALISM AND ANTI-RACISM EDUCATION

Multiculturalism Education

Multiculturalism education stresses the promotion of understanding, respect, and acceptance of cultural diversity within our society.

Multiculturalism education involves:

- recognizing that everyone belongs to a cultural group
- accepting and appreciating cultural diversity as a positive feature of our society
- affirming that all ethnocultural groups are equal within our society
- understanding that multiculturalism education is for all students
- recognizing that similarities across cultures are much greater than differences and that cultural pluralism is a positive aspect in our society
- affirming and enhancing self-esteem through pride in heritage, and providing opportunities for individuals to appreciate the cultural heritage of others
- promoting cross-cultural understanding, citizenship, and racial harmony

Anti-Racism Education

Anti-racism education promotes the elimination of racism through identifying and changing institutional policies and practices as well as identifying individual attitudes and behaviours that contribute to racism.

Anti-racism education involves:

- proposing the need to reflect on one's own attitudes about race and anti-racism
- understanding what causes racism in order to achieve equality
- identifying and addressing racism at both the personal and institutional level
- acknowledging the need to take individual responsibility for eliminating racism
- working toward removing systemic barriers that marginalize groups of people
- providing opportunities for individuals to take action to eliminate all forms of racism, including stereotypes, prejudice, and discrimination

Value of Integrating Multiculturalism and Anti-Racism Education

Multiculturalism and anti-racism education provides learning experiences that promote strength through diversity and social, economic, political, and cultural equity. Multiculturalism and anti-racism education gives students learning experiences that are intended to enhance their social, emotional, aesthetic, artistic, physical, and intellectual development. It provides learners with the tools of social literacy and skills for effective cross-cultural interaction with diverse cultures. It also recognizes the importance of collaboration between students, parents, educators, and communities working toward social justice in the education system.

The key goals of multiculturalism and anti-racism education are:

- to enhance understanding of and respect for cultural diversity
- to increase creative intercultural communication in a pluralistic society
- to provide equal opportunities for educational achievement by all learners, regardless of culture, national origin, religion, or social class
- to develop self-worth, respect for oneself and others, and social responsibility
- to combat and eliminate stereotyping, prejudice, discrimination, and other forms of racism
- to include the experiences of all students in school curricula

Examples of curriculum integration include:

Fine Arts—identifying ways in which the fine arts portray cultural experiences

Humanities—identifying similarities and differences within cultural groups' lifestyles, histories, values, and beliefs

Mathematics or Science—recognizing that individuals and cultural groups have used both diverse and common methods to compute, to record numerical facts, and to measure

Physical Education—developing an appreciation of games and dances from diverse cultural groups

This summary is derived from *Multicultural and Anti-Racism Education—Planning Guide (Draft)*, developed by the Social Equity Branch in 1994.

Science-Technology-Society

Science-Technology-Society (STS) addresses our understanding of inventions and discoveries and of how science and technology affect the well-being of individuals and our global society.

The study of STS includes:

- the contributions of technology to scientific knowledge and vice versa
- the notion that science and technology are expressions of history, culture, and a range of personal factors
- the processes of science and technology such as experimentation, innovation, and invention
- the development of a conscious awareness of ethics, choices, and participation in science and technology

Value of Integrating STS

The aim of STS is to enable learners to investigate, analyse, understand, and experience the dynamic interconnection of science, technology, and human and natural systems.

The study of STS in a variety of subjects gives students opportunities to:

- discover knowledge and develop skills to foster critical and responsive attitudes toward innovation
- apply tools, processes, and strategies for actively challenging emerging issues
- identify and consider the evolution of scientific discovery, technological change, and human understanding over time, in the context of many societal and individual factors

- develop a conscious awareness of personal values, decisions, and responsible actions about science and technology
- explore scientific processes and technological solutions
- contribute to responsible and creative solutions using science and technology

The organizing principles of STS are: Human and Natural Systems, Inventions and Discoveries, Tools and Processes, Society and Change. Each organizer may be developed through a variety of contexts, such as the economy, the environment, ethics, social structures, culture, politics, and education. Each context provides a unique perspective for exploring the critical relationships that exist and the challenges we face as individuals and as a global society.

Examples of curriculum integration include:

Visual Arts—recognizing that demands generated by visual artists have led to the development of new technologies and processes (e.g., new permanent pigments, fritted glazes, drawing instruments)

English Language Arts—analysing the recent influence of technologies on listening, speaking, and writing (e.g., CDs, voice mail, computer-generated speech)

Physical Education—studying how technology has affected our understanding of the relationship between activity and well-being

This summary is derived from *Science-Technology-Society—A Conceptual Framework*, Curriculum Branch, 1994.

SPECIAL NEEDS

Students with special needs have disabilities of an intellectual, physical, sensory, emotional, or behavioural nature; or have learning disabilities; or have exceptional gifts or talents.

All students can benefit from an inclusive learning environment that is enriched by the diversity of the people within it. Opportunities for success are enhanced when provincial learning outcomes and resources are developed with regard for a wide range of student needs, learning styles, and modes of expression.

Educators can assist in creating more inclusive learning environments by introducing the following:

- activities that focus on development and mastery of foundational skills (basic literacy)
- a range of co-operative learning activities and experiences in the school and community, including the application of practical, hands-on skills in a variety of settings
- references to specialized learning resources, equipment, and technology
- ways to accommodate special needs (e.g., incorporating adaptations and extensions to content, process, product, pacing, and learning environment; suggesting alternative methodologies or strategies; making references to special services)
- a variety of ways, other than through paper-and-pencil tasks, for students to demonstrate learning (e.g., dramatizing events to demonstrate understanding of a poem, recording observations in science by drawing or by composing and performing a music piece)
- promotion of the capabilities and contributions of children and adults with special needs
- participation in physical activity

All students can work toward achievement of the provincial learning outcomes. Many students with special needs learn what all students are expected to learn. In some cases the student's needs and abilities require that education programs be adapted or modified. A student's program may include regular instruction in some subjects, modified instruction in others, and adapted instruction in still others. Adaptations and modifications are specified in the student's Individual Education Plan (IEP).

Adapted Programs

An adapted program addresses the learning outcomes of the prescribed curriculum but provides adaptations so the student can participate in the program. These adaptations may include alternative formats for resources (e.g., braille, books-on-tape), instructional strategies (e.g., use of interpreters, visual cues, learning aids), and assessment procedures (e.g., oral exams, additional time). Adaptations may also be made in areas such as skill sequence, pacing, methodology, materials, technology, equipment, services, and setting. Students on adapted programs are assessed using the curriculum standards and can receive full credit.

Modified Programs

A modified program has learning outcomes that are substantially different from the prescribed curriculum and specifically selected to meet the student's special needs. For example, a Grade 5 student in language arts may be working on recognizing common signs and using the telephone, or a secondary student could be mapping the key features of the main street between school and home. A student on a modified program is assessed in relation to the goals and objectives established in the student's IEP.

Appendix D

Assessment and Evaluation

Prescribed learning outcomes, expressed in observable terms, provide the basis for the development of learning activities, and assessment and evaluation strategies. After a general discussion of assessment and evaluation, this appendix uses sample evaluation plans to show how activities, assessment, and evaluation might come together in a particular technology education program.

ASSESSMENT AND EVALUATION

Assessment is the systematic gathering of information about what students know, are able to do, and are working toward. Assessment methods and tools include: observation, student self-assessments, daily practice assignments, quizzes, samples of student work, pencil-and-paper tests, holistic rating scales, projects, oral and written reports, performance reviews, and portfolio assessments.

Student performance is evaluated from the information collected through assessment activities. Teachers use their insight, knowledge about learning, and experience with students, along with the specific criteria they establish, to make judgments about student performance in relation to prescribed learning outcomes.

Students benefit most when evaluation is provided on a regular, ongoing basis. When evaluation is seen as an opportunity to promote learning rather than as a final judgment, it shows learners their strengths and suggests how they can develop further. Students can use this information to redirect efforts, make plans, and establish future learning goals.

Evaluation may take different forms, depending on the purpose.

- Criterion-referenced evaluation should be used to evaluate student performance in classrooms. It is referenced to criteria based on learning outcomes described in the provincial curriculum. The criteria reflect a student's performance based on specific learning activities. When a student's program is substantially modified, evaluation may be referenced to individual goals. These modifications are recorded in an Individual Education Plan (IEP).
- Norm-referenced evaluation is used for large-scale system assessments; it is not to be used for classroom assessment. A classroom does not provide a large enough reference group for a norm-referenced evaluation system. Norm-referenced evaluation compares student achievement to that of others rather than comparing how well a student meets the criteria of a specified set of learning outcomes.

CRITERION-REFERENCED EVALUATION

In criterion-referenced evaluation, a student's performance is compared to established criteria rather than to the performance of other students. Evaluation referenced to prescribed curriculum requires that criteria are established based on the learning outcomes listed under each curriculum organizer for Industrial Design 11 and 12.

Criteria are the basis of evaluating student progress; they identify the critical aspects of a performance or a product that describe in specific terms what is involved in meeting the learning outcomes. Criteria can be used to evaluate student performance in relation to learning outcomes. For example, weighting criteria, using rating scales, or performance rubrics (reference sets) are three ways that student performance can be evaluated using criteria.

Samples of student performance should reflect learning outcomes and identified criteria. The samples clarify and make explicit the link between evaluation and learning outcomes, criteria, and assessment.

Where a student's performance is not a product, and therefore not reproducible, a description of the performance sample should be provided.

Criterion-referenced evaluation may be based on these steps:

Step 1 ▶ Identify the expected learning outcomes (as stated in this Integrated Resource Package).

Step 2 ▶ Identify the key learning objectives for instruction and learning.

Step 3 ▶ Establish and set criteria. Involve students, when appropriate, in establishing criteria.

Step 4 ▶ Plan learning activities that will help students gain the knowledge or skills outlined in the criteria.

Step 5 ▶ Prior to the learning activity, inform students of the criteria against which their work will be evaluated.

Step 6 ▶ Provide examples of the desired levels of performance.

Step 7 ▶ Implement the learning activities.

Step 8 ▶ Use various assessment methods based on the particular assignment and student.

Step 9 ▶ Review the assessment data and evaluate each student's level of performance or quality of work in relation to criteria.

Step 10 ▶ Where appropriate or necessary, assign a letter grade that indicates how well the criteria are met.

Step 11 ▶ Report the results of the evaluations to students and parents.

APPENDIX D

Assessment and Evaluation Samples

The samples in this section show how a teacher might link criteria to learning outcomes. Each sample is based on prescribed learning outcomes taken from one or more organizers. The samples provide background information to explain the classroom context; suggested instructional tasks and strategies; the tools and methods used to gather assessment information; and the criteria used to evaluate student performance.

How the Samples are Organized

There are five parts to each sample:

- identification of the prescribed learning outcomes
- overview
- planning for assessment and evaluation
- defining the criteria
- assessing and evaluating student performance

Prescribed Learning Outcomes

This part identifies the organizer or organizers and the specific prescribed learning outcomes selected for the sample.

Overview

This is a summary of the key features of the sample.

Planning for Assessment and Evaluation

This part outlines:

- background information to explain the classroom context
- instructional tasks
- the opportunities that students were given to practise learning
- the feedback and support that was offered students by the teacher
- the ways in which the teacher prepared students for the assessment

Defining the Criteria

This part illustrates the specific criteria, which are based on prescribed learning outcomes, the assessment task, and various reference sets.

Assessing and Evaluating Student Performance

This part includes:

- assessment tasks or activities
- the support that the teacher offered students
- tools and methods used to gather the assessment information
- the way the criteria were used to evaluate the student performance

Evaluation Samples

The samples on the following pages illustrate how a teacher might apply criterion-referenced evaluation in Industrial Design 11 and 12.

- Sample 1: Grade 11
  Greenhouse Design
  (Page D-8)
- Sample 2: Grade 11
  Alternative Energy Vehicle
  (Page D-13)
- Sample 3: Grade 12
  Power-Assist Device for a Bicycle
  (Page D-19)
- Sample 4: Grade 12
  Rapid-Assembly Shelter
  (Page D-23)

▼ SAMPLE 1: GRADE 11

Topic: *Greenhouse Design*

Prescribed Learning Outcomes:

Design and Communication (Principles and Concepts of Technology)

It is expected that students will:

- describe how product and system designs are influenced by specifications such as:
  - industry standards
  - function
  - availability of resources
  - user requirements

Design and Communication (Problem Solving)

It is expected that students will:

- demonstrate ability to collaborate to analyse and solve design and communication problems

Design and Communication (Modification and Manipulation)

It is expected that students will:

- develop and present design solutions using:
  - manual and computer drafting
  - prototypes and models
  - multimedia
  - computer animation or simulation

Product Development (Problem Solving)

It is expected that students will:

- analyse the effects of design elements in the production process, based on the following factors:
  - principles of engineering
  - standards of quality and reliability
  - reduction of waste
- demonstrate an understanding of the steps involved in managing product development projects

Product Development (Modification and Manipulation)

It is expected that students will:

- apply the processes of combining, forming, separating, and finishing
- apply safe work habits in accordance with established regulations, including WCB and WHMIS regulations

Systems Integration (Principles and Concepts of Technology)

It is expected that students will:

- demonstrate an understanding of the application of computer control, including characteristics and configurations

Systems Integration (Problem Solving)

It is expected that students will:

- justify solutions to systems integration problems

Systems Integration (Modification and Manipulation)

It is expected that students will:

- select and use a variety of input and output devices to achieve specific purposes
- construct control systems or robotics devices that connect components, including:
  - controller
  - manipulator
  - end effector

Overview

The teacher developed a unit in which groups of students researched, designed, and constructed greenhouses. Evaluation was based on:

- greenhouse design and construction
- group work
- problem-solving skills

Planning for Assessment and Evaluation

- The teacher divided the class into four groups and asked each to brainstorm ideas and develop a list of design specifications for a greenhouse. Each group presented its ideas to the class.
- The groups then researched greenhouse designs, temperature control systems, and methods of construction to further develop their design solutions. Their research included a field trip to a working greenhouse.
- Using their research information, the groups developed the following:
  - sketches to explain their ideas
  - flow charts for the planning and construction process and for the integration of the automated temperature control systems
  - formal working drawings, using manual or computer drafting, outlining the construction of the greenhouses and the integration of the control systems
  - materials and components lists with accurate costing
- When the groups completed the design work, they constructed their greenhouses and integrated the automated control systems. Students divided the tasks among group members and regularly communicated with one another to ensure that they met all design requirements.
- As an extension, students tested the effectiveness of their greenhouses and control systems by germinating seeds and growing bedding plants.

Defining the Criteria

Greenhouse Design and Construction

Design Process

To what extent is the group able to:

- develop design specifications that address the function of the product and show appropriate use of resources
- incorporate principles of engineering
- apply industry standards regarding quality and reliability

Presentation

To what extent is the group able to:

- use a variety of communication processes and media to present design solutions
- present ideas in a clear and logical way
- use appropriate technical vocabulary when providing design ideas
- provide a rationale for the chosen design solution

Production Processes

To what extent is the group able to:

- incorporate a functioning control system
- select appropriate construction methods
- demonstrate safe work practices when using tools, equipment, and materials
- apply project-management strategies
- develop a finished product of commercial quality

Group Work

To what extent does the student:

- participate willingly and constructively in the group

- initiate, develop, and sustain interactions in the group
- contribute ideas and build on the ideas of others

Problem Solving

To what extent does the student:

- engage in design and production problems
- use background knowledge appropriately
- use effective problem-solving processes
- present solutions to problems

Assessing and Evaluating Student Performance

Greenhouse Design and Construction

The teacher used a rating scale to evaluate each group's work in designing and constructing a greenhouse.

Group Work

The teacher used two sections ("Social" and "Ideas") of the reference set *Evaluating Oral Communication Across Curriculum* as the basis for a rating scale to assess individual students' contributions to their groups. The teacher collected information about student performance by observing them as they worked.

Problem Solving

As students worked on their design and production problems, the teacher observed and recorded their problem-solving performance using the "Individual Observation Checklist" from the reference set *Evaluating Problem Solving Across Curriculum.*

Greenhouse Design and Construction

Criteria	Rating					
	5	4	3	2	1	0
Design Process						
• develops design specifications that address the function of the product and show appropriate use of resources						
• incorporates principles of engineering						
• applies industry standards regarding quality and reliability						
Presentation						
• uses a variety of communication processes to develop and present design solutions						
• presents ideas in a clear and logical way						
• uses appropriate technical vocabulary when providing design ideas						
• provides a rationale for the chosen design solution						
Production Processes						
• incorporates a functioning control system						
• selects appropriate construction methods						
• demonstrates safe work practices when using tools, equipment, and materials						
• applies project-management strategies						
• develops a finished product of commercial quality						

Key: 5—Excellent; criterion met to an exceptional or unusual degree.
4—Very good; criterion met in a very effective way.
3—Good; criterion met in a competent and an effective fashion.
2—Satisfactory; criterion met but with considerable room for improvement.
1—Minimally acceptable; criterion met to some extent.
0—Not evident; criterion not met.

Group Work

Rating	Criteria	
	Social Interaction	**Ideas Development**
5 • Shapes the way the group works. • Develops and extends the group's work.	The student is able to initiate, develop, and sustain interactions so that the group is able to work together harmoniously. Frequently encourages the efforts of other group members, often asking them questions. The student is comfortable, but not driven, in providing leadership when needed. Attempts to resolve conflicts among other group members and is able to let go of own ideas to further progress of the group. Approaches the task with obvious enjoyment, often accompanied with humour.	The student participates in all phases of the activity, although contributions may vary according to the relevant information or experience he or she possesses. Provides constructive feedback, offers predictions and hypotheses, and poses intriguing questions. The student is able to offer clarification, elaboration, or explanation as needed, and builds upon and, in some cases, synthesizes the ideas others offer. May use comparisons, analogies, examples, or humour to illustrate or emphasize a point.
4 • Social interactions comfortable and well developed. • Flexible attitude and well-developed ideas.	The student is comfortable working in a group and contributes to the social dynamics. May take a leadership role in organizing how the group will interact. The student takes responsibility for the group process by facilitating and extending discussion and persevering beyond initial solutions. Is responsive to other group members and their ideas. While the student tends to interact effectively, he or she may not have much effect on how the other group members work with one another.	The student contributes ideas, experience, and information that the group is able to use. May help to develop ideas by providing details, examples, reasons, and explanations. The student often makes suggestions, asks questions, or adjusts thinking after listening to others. May also rephrase, paraphrase, or pose questions as a way of challenging or building on ideas from other group members. The student is able to make relevant connections to other situations or ideas.
3 • Socially engaged. • Ideas are appropriate and related to the task.	The student takes part in the group discussion and follows the basic rules for working with others—taking turns, listening while others are speaking, and sometimes offering recognition or support. May ask for or offer needed information. The student is willing to accept group decisions and may share some responsibility for how the group works.	The student contributes some suggestions and ideas to the group. Responds and sometimes adds to suggestions that others make, participates in brainstorming activities, shows interest in others' ideas, and adds information. The student may not defend her or his ideas and tends to give in quickly when someone disagrees.
2 • Inconsistent social interactions. • Ideas often disconnected.	The student may begin to show some awareness of the responsibilities of contributing to a group. May sometimes recognize and respond to the needs and ideas of others and show appreciation or support. At other times, the student may have difficulty taking turns or accepting suggestions from other students. The student may remain uncommitted, focussing on own needs rather than the group's task.	The student contributes ideas to the group that address the task, but these may be unconnected to the ideas of others. May offer several suggestions, but appears unable to elaborate, explain, or clarify ideas. Often relates the activity to personal experiences by telling stories. The student may think out loud, judge others' ideas quickly, or drift off task easily.
1 • Largely unaware of others' needs. • Limited contribution of ideas.	The student may not understand how his or her behaviour affects others, and may be disruptive, aggressive, uninvolved, or easily frustrated.	The student may remain silent throughout the activity, contribute one idea repeatedly, or recount personal experiences unrelated to the group task. May not acknowledge or add to the contributions of other group members, but may respond to direct questions or other prompts from adults.

▼ Sample 2: Grade 11

Topic: *Alternative Energy Vehicle*

Prescribed Learning Outcomes:

Product Development (Modification and Manipulation)

It is expected that students will:

- apply safe work habits in accordance with established regulations, including WCB and WHMIS regulations

Energy, Power, and Transportation (Principles and Concepts of Technology)

It is expected that students will:

- compare ways of using emerging and alternative energy sources to power mechanical devices
- describe the impact of energy, power, and transportation systems on society and the environment

Energy, Power, and Transportation (Problem Solving)

It is expected that students will:

- apply teamwork skills to solve problems involving mechanical systems and subsystems

Energy, Power, and Transportation (Modification and Manipulation)

It is expected that students will:

- use tools and equipment accurately and efficiently to achieve design and assembly specifications that meet manufacturer and industry standards
- construct a device or system that is energy efficient

Overview

The teacher planned a unit in which groups of students designed, built, and tested scale models of alternative energy vehicles. Evaluation was based on:

- understanding of alternative energy sources
- safety awareness
- group work and diagnostic skills
- vehicle prototypes

Planning for Assessment and Evaluation

- The teacher introduced the class to alternative energy vehicles by showing a videotape on the topic. This was followed by a discussion of the benefits and drawbacks of various transportation systems, including the impact these systems have on society and the environment. Students discussed possible future modes of transportation and how existing, emerging, and alternative energy sources might affect the design and efficiency of future vehicles.

- The teacher then asked students to design, build, and test scale models of vehicles that would cover the greatest distance using the least amount of energy.

- Working in groups, students researched the various alternative energy options available and then chose either to use existing alternative energy sources in their designs or to propose alternative energy sources of their own. If they chose their own alternative sources, for safety reasons they presented their ideas to the teacher before using them in their designs.

- The teacher discussed with students the principles of energy transmission and conversion, and the relationship between wheel size and gear ratio. They were given opportunities to experiment with various gear ratios and wheel sizes using modelling kits.

- The teacher also instructed students in the safe use of the tools and machines they would use to process the materials needed to fabricate their vehicles.
- The teacher referred students to the use of the feedback loop in the design process, and they were expected to test and evaluate their designs during each stage of development.
- When students completed their design work, they manufactured their prototype vehicles and tested them for energy efficiency.

DEFINING THE CRITERIA

Understanding Alternative Energy Sources

To what extent is the student able to:

- identify a variety of emerging and alternative energy sources
- describe ways that energy sources are used to power mechanical devices
- identify the social and environmental impact of using various energy sources

Safety

To what extent does the student:

- demonstrate a serious attitude toward safety issues
- encourage others to work safely
- exhibit personal preparedness with respect to clothes, jewellery, and protective equipment
- identify and use correct procedures to ensure health and safety

Group Work and Diagnostic Skills

To what extent does the student:

- participate willingly and constructively in the group
- initiate, develop, and sustain interactions in the group
- contribute ideas and build on the ideas of others
- approach problems systematically
- identify interrelationships between various parts
- identify the effect of a failed component on the system
- explore alternative solutions
- use appropriate tools and testing equipment

Prototype

To what extent does the prototype demonstrate:

- quality construction and attention to detail
- efficient use of energy
- aesthetic appeal
- innovation in design

ASSESSING AND EVALUATING STUDENT PERFORMANCE

Understanding Alternative Energy Sources

As students worked on their projects, the teacher conferenced with them individually, asking questions to determine the extent of their understanding of alternative energy sources. The teacher recorded student performance using a rating scale.

Safety

The teacher used a performance scale to record individual students' attitudes, knowledge, and actions with respect to safety. The teacher collected information on student performance from safety quizzes and classroom observations.

Group Work and Diagnostic Skills

The teacher observed individual students as they worked in their groups and used a checklist to record their group work and diagnostic skills.

Prototype

The teacher and peers assessed each group's prototype vehicle using a rating scale. Scores given by the teacher and peers were combined to arrive at the group's grade.

Understanding Alternative Energy Sources

Criteria	Rating (0 to 5)	Comments
• identifies a variety of emerging and alternative energy sources		
• describes ways that energy sources are used to power mechanical devices		
• identifies the social and environmental impact of using various energy sources		

Key: **5**—Excellent; criterion met to an exceptional or unusual degree.
4—Very good; criterion met in a very effective way.
3—Good; criterion met in a competent and an effective fashion.
2—Satisfactory; criterion met but with considerable room for improvement.
1—Minimally acceptable; criterion met to some extent.
0—Not evident; criterion not met.

Safety

Rating	Criteria
Outstanding	The student has an exceptional "heads up" attitude toward safety issues. Demonstrates an outstanding understanding of safety issues and procedures in both theory and practical application. The student works safely with minimal teacher supervision and encourages other students to do so as well.
Competent	The student has a serious attitude toward safety issues and follows all safety instructions given by the teacher. On quizzes, she or he demonstrates good background knowledge about safety issues. The student completes the operating procedure sheet on each machine before using the equipment. Before working, the student takes necessary safety precautions. The student lifts and carries objects correctly with respect to both health and safety. The student does not endanger other members of the group or class when working.
Unacceptable	The student either cannot identify safety issues and appropriate safety measures or can identify them in a quiz situation but does not apply them when working unless under excessive supervision. The student sometimes engages in horseplay that endangers self and others.

Group Work and Diagnostic Skills

Criteria	Rating		
	Always	Sometimes	Not Observed
Group Work			
• participates willingly and constructively in the group			
• initiates, develops, and sustains interactions in the group			
• contributes ideas and builds on the ideas of others			
Diagnostic Skills			
• approaches a problem systematically			
• identifies interrelationships between various parts			
• identifies the effect of a failed component on the system			
• explores alternative solutions			
• uses appropriate tools and testing equipment			

Prototype

Criteria	Rating		
	Possible	Peer Rating	Teacher Rating
• quality of construction and attention to detail	**10**		
• efficient use of energy	**20**		
• aesthetic appeal	**10**		
• innovation in design	**10**		

▼ Sample 3: Grade 12

Topic: *Power-Assist Device for a Bicycle*

Prescribed Learning Outcomes:

Product Development (Modification and Manipulation)

It is expected that students will:

- interpret design representations (drawings, plans, schematics) to assist in developing a product or system
- apply appropriate production processes (combining, forming, separating, finishing) to create products and systems that conform to:
  - specified design criteria (form, function, aesthetics, ergonomics, end-user needs)
  - recognized standards, conventions, and tolerances

Systems Integration (Problem Solving)

It is expected that students will:

- analyse and solve problems related to the performance of systems and subsystems
- demonstrate teamwork skills in group problem-solving situations

Energy, Power, and Transportation (Principles and Concepts of Technology)

It is expected that students will:

- describe ways to integrate emerging and alternative energy sources to power mechanical devices

Energy, Power, and Transportation (Problem Solving)

It is expected that students will:

- modify transportation devices and power systems to improve performance or efficiency
- develop models to test or interpret the action of mechanical devices

Energy, Power, and Transportation (Modification and Manipulation)

It is expected that students will:

- design and construct electrical, hydraulic, or pneumatic control systems that convert or transmit energy and power

Overview

The teacher planned a unit in which students developed designs for power-assist devices for a bicycle. Evaluation was based on:

- production skills
- diagnostic skills
- group work
- problem-solving skills

Planning for Assessment and Evaluation

- The teacher introduced the topic of bicycle design by presenting a variety of bicycle styles (e.g., mountain bikes, children's bikes, racing bikes, BMX bikes). The class examined the bicycles to see how form relates to function and learned how bicycle designs have been adapted to meet different needs or uses.

- The teacher then presented the following scenario: An elderly person uses a bicycle as a form of transportation between her home and the local grocery store. Between the two locations is a hill that is difficult for her to negotiate.

- Students then worked in teams to develop design solutions for a safe, cost-effective, efficient, and environmentally friendly power-assist device for the bicycle. They conducted research to collect information about available power-assist devices and possible methods of transferring power to the wheels of the bicycle. Students used various sources for their research (e.g., local bicycle shops, electric-motor suppliers, library books, the Internet).

- The teacher instructed students on the principles of energy transmission and conversion and on the relationship between motor speed and torque, focussing on industrial motors that are suitable for high-torque applications. They were given opportunities to model systems using a variety of motors.
- The teams then used the information they had gathered to develop sketches explaining their ideas. They created formal working drawings, using manual drafting or CADD, showing the integration of the power-assist devices with bicycles. They also compiled materials and components lists.
- Students fabricated components needed to attach the power-assist devices to bicycles, and then tested them for effectiveness. They were encouraged to modify their designs as necessary in order to achieve optimal results.
- As an extension activity, some groups developed marketing plans for their devices.

DEFINING THE CRITERIA

Production Skills

To what extent is the student able to:

- select appropriate tools for the task
- set up tools correctly for the operation required
- use correct jigs, fixtures, or accessories
- use appropriate safety equipment and procedures
- sequence operations correctly

Diagnostic Skills

To what extent does the student:

- approach problems systematically
- identify interrelationships between various parts
- identify the effect of a failed component on the system
- explore alternative solutions
- use appropriate tools and testing equipment

Group Work

To what extent does the student:

- participate willingly and constructively in the group
- initiate, develop, and sustain interactions in the group
- contribute ideas and build on the ideas of others

Problem Solving

To what extent does the student:

- engage in design and production problems
- use background knowledge appropriately
- use effective problem-solving processes
- represent solutions to problems

ASSESSING AND EVALUATING STUDENT PERFORMANCE

Production Skills

The teacher observed individual students as they worked and used a performance scale to record production skills.

Diagnostic Skills

The teacher observed students' diagnostic skills and used an observation checklist to record performance.

Group Work

The teacher used two sections ("Social" and "Ideas") of the reference set *Evaluating Oral Communication Across Curriculum* as the basis for a rating scale to assess individual students' contributions to their groups. (See Sample 1, page D-12.) The teacher collected information about student performance by observing them as they worked.

Problem Solving

At the end of the production process, students were asked to self-evaluate their problem-solving skills using the "Student Self-Evaluation Checklist" from the reference set *Evaluating Problem Solving Across Curriculum.*

Production Skills

Criteria	Rating			
	3	2	1	0
• selects appropriate tools for the task	Consistently selects appropriate tools for the task.	Recognizes the need to select the correct tools, but may need direction occasionally.	Frequently needs direction in the selection of tools.	Does not seek direction and often selects inappropriate tools.
• sets up tools correctly for the operation required	Consistently sets up tools for optimum performance and safety.	May occasionally need direction in setting up tools.	Generally needs to be shown how to set up tools for particular tasks.	Does not set up own tools.
• uses correct jigs, fixtures, or accessories	Consistently uses correct jigs and fixtures, or independently designs own.	Uses correct jigs and fixtures, but needs assistance to design new ones.	Needs help in selecting jigs and fixtures.	Does not understand the use of jigs and fixtures.
• uses appropriate safety equipment and procedures	Consistently attends to safety issues and encourages other students to do so as well.	Consistently uses safety equipment and procedures.	Understands the need for safety equipment and procedures, but occasionally needs reminders.	Does not use safety equipment and procedures without constant monitoring and reminding.
• sequences operations correctly	Plans and follows correct sequencing procedures.	Follows teacher suggestions for sequencing work.	Occasionally has problems following teacher suggestions for sequencing.	Does not follow suggested sequence of machine operations.

Diagnostic Skills

Criteria	Rating		
	Always	Sometimes	Not Observed
• identifies relationships between various parts			
• identifies the effect of a failed component on the system			
• explores alternative solutions			
• uses appropriate tools and testing equipment			

▼ Sample 4: Grade 12

Topic: *Rapid-Assembly Shelter*

Prescribed Learning Outcomes:

Design and Communication (Principles and Concepts of Technology)

It is expected that students will:

- describe representation and modelling techniques used to develop design solutions, proposals, and plans
- synthesize knowledge and concepts from other disciplines and the community in the design process
- assess how design reflects society, culture, and the environment

Design and Communication (Modification and Manipulation)

It is expected that students will:

- design products and systems and select appropriate materials and components to reflect specified design criteria, including:
  - method of production
  - cost
  - aesthetics
  - function
  - environmental considerations
- use appropriate tools and equipment to develop and present design ideas, including:
  - manual drafting
  - CADD
  - computer animation or simulation
  - video and audio production
  - models
- produce working drawings that incorporate recognized standards

Overview

The teacher planned a unit in which students designed and constructed scale models of a emergency shelters. Evaluation was based on:

- designs
- scale models

Planning for Assessment and Evaluation

- The teacher showed the class a videotape of an earthquake and its aftermath. Afterward, the teacher initiated a discussion about relief agencies that provide emergency shelters for families after natural disasters.

- Students then worked in teams to design and construct 1:10 scale models of emergency shelters that would meet the following user requirements:
  - large enough to accommodate four to six adults
  - constructed from sections that can be fitted together easily or are in fold-down assembly form
  - protects the occupants from wind, rain, and sub-zero temperatures

- Each group also produced a design portfolio that included:
  - descriptions and initial sketches of several design options, with reasons for rejected alternatives
  - evidence of developmental work
  - detailed manual or CADD scale drawings of the group's selected design, including a three-view drawing using orthographic projection, a rendered pictorial drawing using two-point perspective, a detail drawing showing a joint used in the structure, and an exploded view showing how to assemble the structure

- an evaluation of the overall project, including self-criticism where appropriate, detailed reasons for the success of the project, or detailed suggestions for modifications and alterations to improve it

- After doing the design work, each team produced a realistic, three-dimensional 1:10 scale model that clearly demonstrated the assembly process.
- At the end of the activity, the finished models were displayed and were then evaluated by the teacher, peers, and other interested staff members. The design portfolios were handed in and were also evaluated by the teacher and peers.

DEFINING THE CRITERIA

Design

To what extent is the group able to:

- frame a well-developed design brief with detailed specifications
- present research that is comprehensive, well organized, and well documented
- generate several possible design solutions that meet the design specifications
- produce high-quality drawings that detail the final design, incorporating sufficient detail and information to permit manufacture of the product
- provide evidence of project planning in the form of written procedures and flow charts
- complete a detailed evaluation of the product that is relevant, concise, and objective and that addresses issues such as cost, function, environmental impact, and method of production

Scale Model

To what extent does the model exhibit:

- high-quality design features
- high-quality construction techniques
- high-quality finishing techniques
- satisfaction of design criteria

ASSESSING AND EVALUATING STUDENT PERFORMANCE

Design

Assessment of the design process was based on teacher observations and teacher and peer assessment of the design portfolios.

Scale Model

Each group's model was evaluated by the teacher and peers. Teacher and peer evaluations were averaged to arrive at a final grade.

Design Project

Name: ______________________ Project: ______________________

		COMMENTS
Framing a Design Brief		
• brief and specifications poorly developed	1	
• help required to produce brief and identify specifications	2	
• produces simple brief, specifications broadly stated	3	
• produces satisfactory brief and specifications	4	
• well-developed design brief and detailed specifications	5	
Investigation and Research		
• minimal research and investigation conducted	1	
• research conducted but lacking depth	2	
• research presented from several sources	3	
• satisfactory research conducted with minimal assistance	4	
• research comprehensive, well organized, and well documented	5	
Generation of Ideas		
• only one idea presented	1	
• two ideas generated, only one seriously considered	2	
• a variety of ideas generated	3	
• a variety of ideas generated with distinct differences	4	
• several ideas generated that meet design specifications	5	
Developmental Work		
• little evidence of developmental work	1	
• some developmental work based on one idea	2	
• developmental work illustrates design details	3	
• accurate sketches, drawings, and renderings presented	4	
• high-quality drawings detailing final design	5	
Planning		
• minimal evidence of planning	1	
• identifies key stages of planning process	2	
• key stages organized in logical sequence	3	
• detailed requirements identified for each stage	4	
• detailed planning includes flow charts	5	
Evaluation and Testing		
• evaluation irrelevant or largely superficial	1	
• evaluation based on aesthetic and functional qualities only	2	
• evaluation includes self-criticism and relevant observations	3	
• valid judgments with recommendations for improvement	4	
• detailed evaluation that is relevant, concise, and objective	5	

Scale Model

Criteria	Rating			
	Excellent	**Good**	**Fair**	**Poor**
• quality of construction				
• quality of design features				
• quality of finish				
• extent to which the model meets the design criteria				

Appendix E

Acknowledgments

Many people contributed their expertise to this document. The project co-ordinator was Douglas Halladay of the Curriculum and Resources Branch, working with evaluators and reviewers, Ministry of Education, Skills and Training personnel, and our partners in education. Additional reviews of this Integrated Resource Package were carried out by school districts, teacher organizations, and others. We would like to thank all who participated in this process.

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