THE PROGRAM IN TECHNOLOGICAL EDUCATION

OVERVIEW OF THE PROGRAM

The technological education curriculum in Grades 9–12 encompasses ten subject areas, as follows:

Communications Technology
Computer Technology
Construction Technology
Green Industries
Hairstyling and Aesthetics
Health Care
Hospitality and Tourism
Manufacturing Technology
Technological Design
Transportation Technology

The technological education program in Grades 11 and 12 is designed to enable students to select courses that relate to their interests and that will prepare them for further study or work in the technological field of their choice. The Grade 11 and 12 curriculum includes destination-related course types, including university/college preparation, college preparation, and workplace preparation courses, as well as open courses. The course types are defined as follows:

- ***University/college preparation courses*** *are designed to equip students with the knowledge and skills they need to meet the entrance requirement for specific programs offered at universities and colleges.*
- ***College preparation courses*** *are designed to equip students with the knowledge and skills they need to meet the requirements for entrance to most college programs or for admission to apprenticeship or other training programs.*
- ***Workplace preparation courses*** *are designed to equip students with the knowledge and skills they need to meet the expectation of employers, if they plan to enter the workforce directly after graduation, or the requirements for admission to certain apprenticeship or other training programs.*
- ***Open courses*** *are designed to broaden students' knowledge and skills in subjects that reflect their interests and prepare them for active and rewarding participation in society. They are not designed with the specific requirement of universities, colleges, or the workplace in mind.*

At least two of these course types are represented in most subject areas of the Grade 11–12 technological education curriculum (e.g., in computer technology, both university/college preparation and workplace preparation courses are provided). It should be noted that for

students planning to pursue an apprenticeship pathway, either college preparation courses or workplace preparation courses may be the appropriate choice, depending on the subject area.

In Grades 11 and 12, *destination-related* technological education courses may be delivered as courses that emphasize a particular area of the subject and/or as multiple-credit courses (see the following sections for detailed guidelines. Note that these options apply only to destination-related courses, not to open courses). The availability of these options allows school boards the flexibility to design programs that meet the specific needs of their school communities within the parameters of a standardized, rigorous curriculum for technological education for schools across the province.

Although courses in technological education are optional, students should keep in mind that they can take any Grade 9–12 technological education course to fulfil the Group 3 additional compulsory credit requirement for the Ontario Secondary School Diploma.[2] There is no restriction on the total number of technological education credits that students may earn in secondary school.

Grade 11 and 12 technological education courses are ideally suited for cooperative education programs and are often included in programs that lead to a diploma with a Specialist High Skills Major designation.

Courses in Technological Education, Grades 11 and 12*

Grade	Course Name	Course Type	Course Code**	Prerequisite
Communications Technology				
11	Communications Technology	University/College	TGJ3M	None
11	Communications Technology: Broadcast and Print Production	Open	TGJ3O	None
12	Communications Technology	University/College	TGJ4M	Grade 11 Communications Technology, University/College
12	Communications Technology: Digital Imagery and Web Design	Open	TGJ4O	None
Computer Technology				
11	Computer Engineering Technology	University/College	TEJ3M	None
11	Computer Technology	Workplace	TEJ3E	None
12	Computer Engineering Technology	University/College	TEJ4M	Grade 11 Computer Engineering Technology, University/College
12	Computer Technology	Workplace	TEJ3E	Grade 11 Computer Technology, Workplace

* Each Grade 11 and 12 course has a credit value of 1. (Half-credit and multiple-credit courses may be developed according to conditions described in this document.)

** Course codes consist of five characters. The first three characters identify the subject; the fourth character identifies the grade (i.e., 3 and 4 refer to Grade 11 and Grade 12, respectively); and the fifth character identifies the type of course (i.e., M means "university/college preparation"; C means "college preparation"; E means "workplace preparation"; and O means "open").

2. To meet the Group 3 additional compulsory credit requirement, students have the choice of earning one credit for a course in technological education (Grades 9 to 12) or computer studies (Grades 10 to 12), or one credit for an additional course in science (Grade 11 or 12), or one credit for a cooperative education course.

Grade	Course Name	Course Type	Course Code**	Prerequisite
Construction Technology				
11	Construction Engineering Technology	College	TCJ3C	None
11	Construction Technology	Workplace	TCJ3E	None
11	Custom Woodworking	Workplace	TWJ3E	None
12	Construction Engineering Technology	College	TCJ4C	Grade 11 Construction Engineering Technology, College
12	Construction Technology	Workplace	TCJ4E	Grade 11 Construction Technology, Workplace
12	Custom Woodworking	Workplace	TWJ4E	Grade 11 Custom Woodworking, Workplace
Green Industries				
11	Green Industries	University/College	THJ3M	None
11	Green Industries	Workplace	THJ3E	None
12	Green Industries	University/College	THJ4M	Grade 11 Green Industries, University/College
12	Green Industries	Workplace	THJ4E	Grade 11 Green Industries, Workplace
Hairstyling and Aesthetics				
11	Hairstyling and Aesthetics	Workplace	TXJ3E	None
12	Hairstyling and Aesthetics	Workplace	TXJ4E	Grade 11 Hairstyling and Aesthetics, Workplace
Health Care				
11	Health Care	University/College	TPJ3M	None
11	Health Care	College	TPJ3C	None
12	Health Care	University/College	TPJ4M	Grade 11 Health Care, University/College
12	Health Care	College	TPJ4C	Grade 11 Health Care, College
12	Child Development and Gerontology	College	TOJ4C	None
12	Health Care: Support Services	Workplace	TPJ4E	None
Hospitality and Tourism				
11	Hospitality and Tourism	College	TFJ3C	None
11	Hospitality and Tourism	Workplace	TFJ3E	None
12	Hospitality and Tourism	College	TFJ4C	Grade 11 Hospitality and Tourism, College
12	Hospitality and Tourism	Workplace	TFJ4E	Grade 11 Hospitality and Tourism, Workplace

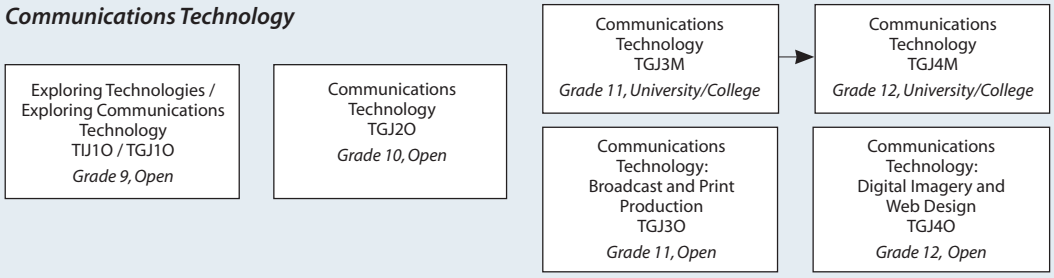
(continued)

Courses in Technological Education, Grades 11 and 12 *(continued)*				
Grade	**Course Name**	**Course Type**	**Course Code****	**Prerequisite**
Manufacturing Technology				
11	Manufacturing Engineering Technology	University/College	TMJ3M	None
11	Manufacturing Technology	College	TMJ3C	None
11	Manufacturing Technology	Workplace	TMJ3E	None
12	Manufacturing Engineering Technology	University/College	TMJ4M	Grade 11 Manufacturing Engineering Technology, University/College
12	Manufacturing Technology	College	TMJ4C	Grade 11 Manufacturing Technology, College
12	Manufacturing Technology	Workplace	TMJ4E	Grade 11 Manufacturing Technology, Workplace
Technological Design				
11	Technological Design	University/College	TDJ3M	None
11	Technological Design and the Environment	Open	TDJ3O	None
12	Technological Design	University/College	TDJ4M	Grade 11 Technological Design, University/College
12	Technological Design in the Twenty-first Century	Open	TDJ4O	None
Transportation Technology				
11	Transportation Technology	College	TTJ3C	None
11	Transportation Technology: Vehicle Ownership	Open	TTJ3O	None
12	Transportation Technology	College	TTJ4C	Grade 11 Transportation Technology, College
12	Transportation Technology: Vehicle Maintenance	Workplace	TTJ4E	None

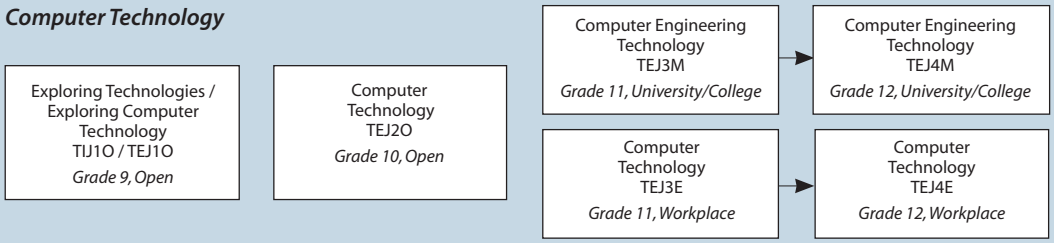
Prerequisite Charts for Technological Education, Grades 9–12

These charts map out all the courses in the discipline and show the links between courses and the possible prerequisites for them. They do not attempt to depict all possible movements from course to course.

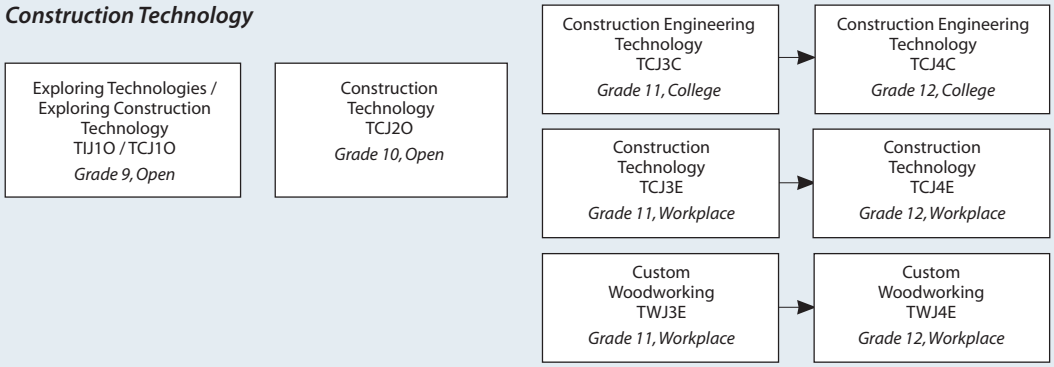
Communications Technology



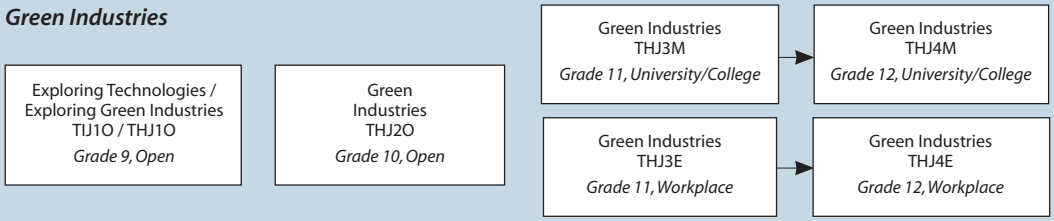
Computer Technology



Construction Technology



Green Industries



Hairstyling and Aesthetics

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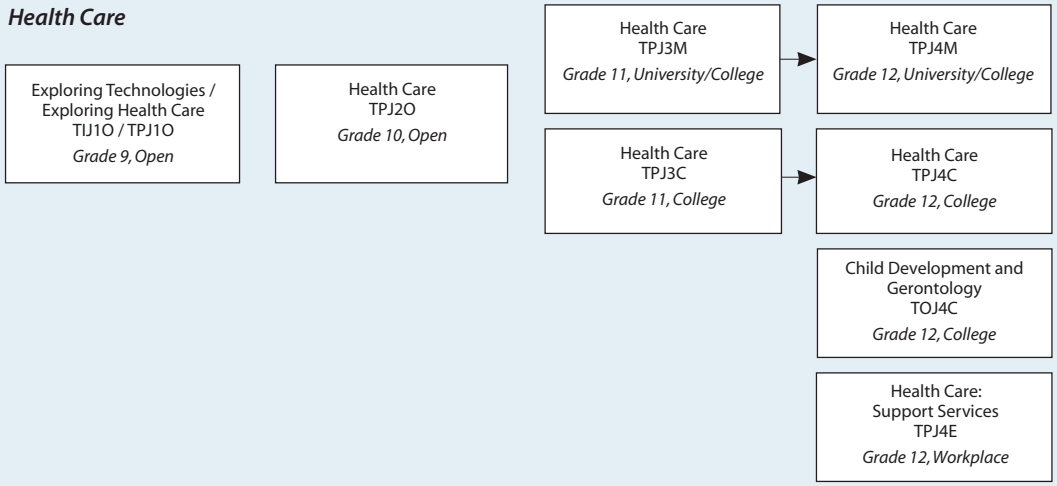
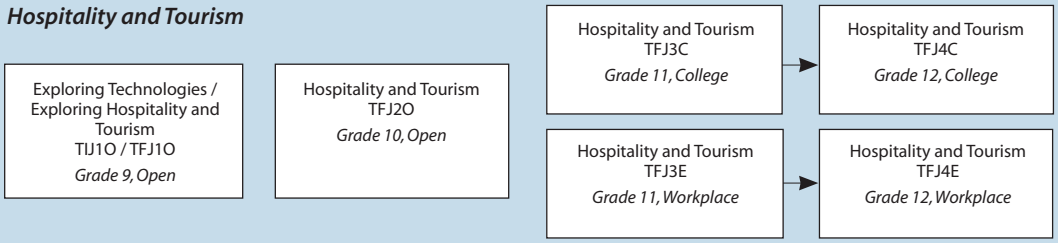
Prerequisite Charts for Technological Education, Grades 9–12 *(continued)*

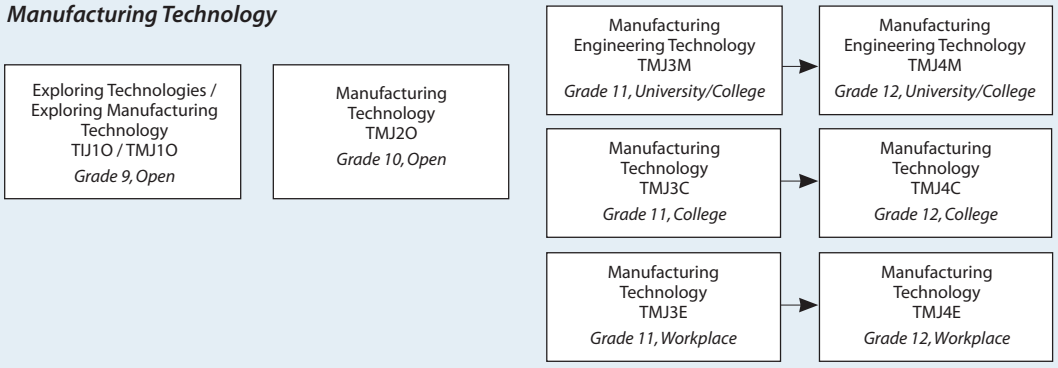
Health Care



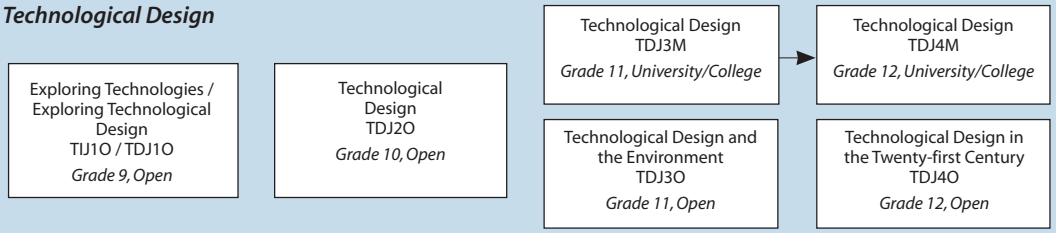
Hospitality and Tourism



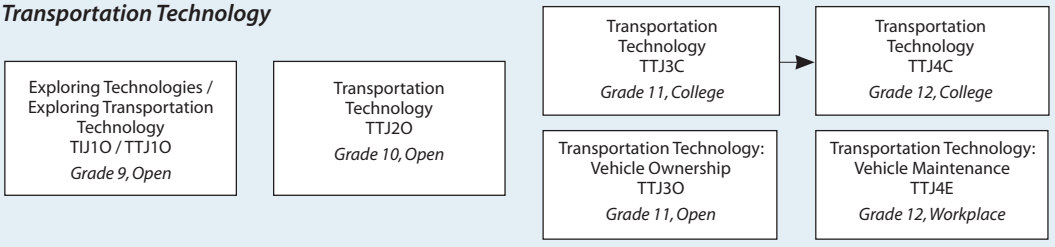
Manufacturing Technology



Technological Design



Transportation Technology



Options for Course Delivery in Grades 11 and 12

Emphasis Courses

In Grades 11 and 12, a destination-related[3] broad-based technology course may be developed to emphasize a particular area of the subject (that is, an area related to a particular sector or particular occupations connected with the subject). For example, a workplace preparation course in computer technology could emphasize computer repair, or a university/college preparation course in technological design could be developed to emphasize apparel and textile design. However, an emphasis course must not entirely exclude other areas of the subject that relate to different sectors or occupations.

The topics and applications that must be addressed in an emphasis course are evident from the course description and the expectations and examples provided for the broad-based course outlined in this document. For example, it is expected that students taking a one-credit (110-hour) Grade 11 university/college preparation course in green industries with an emphasis on forestry will nevertheless explore all areas of the green industries, including agribusiness, horticulture management and science, and landscaping architecture,[4] and that the course will be delivered according to the philosophy of broad-based technological education outlined in this document (see p. 7). (Teachers will notice that the examples that accompany many of the specific expectations in courses outlined in this document are designed to illustrate the expectation from the perspective of several possible emphasis areas.)

Regardless of the area emphasized in a course, students must be given the opportunity to achieve all of the expectations of the course outlined in this document.

The emphasis courses that may be developed in each technological education subject can be identified, along with the course codes that must be assigned to them, from the list of Common Course Codes on the Ministry of Education's website (at www.edu.gov.on.ca). In school calendars, the course description for the emphasis course may be created by adding an additional sentence to the course description provided in this document.

A student may take, and earn credit for the successful completion of, more than one course in any given technological education subject in Grade 11 and/or Grade 12. For example, a student may take two Grade 11 university/college preparation health care courses, one emphasizing dental services and another focusing on pharmacy services (these emphasis areas are specified on the ministry website). Similarly, a student might take the regular broad-based Grade 12 workplace preparation course in hospitality and tourism (as outlined in this document), as well as another Grade 12 hospitality and tourism workplace preparation course, developed on the basis of the same set of expectations but emphasizing baking.

Multiple-Credit Courses

A destination-related[5] broad-based technology course in Grade 11 or 12 may be planned for up to 330 hours of scheduled instructional time (for which the student may earn a maximum of three credits) if the course is part of a Specialist High Skills Major program or school–work transition program, if it leads to an apprenticeship or certification program, or if it supports an articulation agreement for advanced standing or preferred

3. In Grades 11 and 12, open courses may not be offered as emphasis courses.
4. If the course is developed as a multiple-credit course, the first 110 hours of the course must be delivered in this way, addressing all areas within the subject. The remaining instructional time may be dedicated to the specified area of emphasis.
5. In Grades 11 and 12, open courses may not be offered as multiple-credit courses.

entrance into a specialized program. The additional instructional time allows for the practice and refinement of skills needed to raise the quality of the student's performance to the level required for entry into a subsequent program or the workplace. The skills students develop in multiple-credit courses should reflect current industry practices and standards.

Instructional time may be increased by increments of 55 hours. For each additional 55 hours, students earn an additional half-credit, to a maximum of three credits. The number of additional credits and the nature of the knowledge and skills to be practised and refined during the additional instructional time must be established before the start of the course.

Any destination-related course, including emphasis courses, may be delivered as a multiple-credit course.

Half-Credit Courses

The courses outlined in the technological education curriculum documents are designed as full-credit courses. However, *with the exception of the Grade 12 university/college preparation courses*, they may also be delivered as half-credit courses.

Half-credit courses, which require a minimum of fifty-five hours of scheduled instructional time, must adhere to the following conditions:

- The two half-credit courses created from a full course must together contain all of the expectations of the full course. The expectations for each half-credit course must be drawn from all strands of the full course and must be divided in a manner that best enables students to achieve the required knowledge and skills in the allotted time.
- A course that is a prerequisite for another course in the secondary curriculum may be offered as two half-credit courses, but students must successfully complete both parts of the course to fulfil the prerequisite. (Students are not required to complete both parts unless the course is a prerequisite for another course they wish to take.)
- The title of each half-credit course must include the designation *Part 1* or *Part 2*. A half credit (0.5) will be recorded in the credit-value column of both the report card and the Ontario Student Transcript.

Boards will ensure that all half-credit courses comply with the conditions described above, and will report all half-credit courses to the ministry annually in the School October Report.

CURRICULUM EXPECTATIONS

The expectations identified for each course describe the knowledge and skills that students are expected to develop and demonstrate in their class work, on tests, and in various other activities on which their achievement is assessed and evaluated.

Two sets of expectations are listed for each strand, or broad curriculum area, of each course. (The strands are numbered A, B, C, D, and, in some courses, E.)

- The *overall expectations* describe in general terms the knowledge and skills that students are expected to demonstrate by the end of each course.
- The *specific expectations* describe the expected knowledge and skills in greater detail. The specific expectations are grouped under numbered subheadings, each of which indicates the strand and the overall expectation to which the subgrouping of

specific expectations corresponds (e.g., "B2" indicates that the group relates to overall expectation 2 in strand B). The subheadings may serve as a guide for teachers as they plan learning activities for their students.

The organization of expectations into strands and subgroupings is not meant to imply that the expectations in any one strand or group are achieved independently of the expectations in the other strands or groups. The strands and subgroupings are used merely to help teachers focus on particular aspects of knowledge and skills as they develop various learning activities for their students. The concepts, content, and skills identified in the different strands of each course should, wherever appropriate, be integrated in instruction throughout the course.

Many of the specific expectations are accompanied by examples, which are given in parentheses and italicized. These examples are meant to illustrate the kind of knowledge or skill, the specific area of learning, the depth of learning, and/or the level of complexity that the expectation entails. In addition, the examples provided within a broad-based technological education course may collectively reflect the range of areas represented within a given subject (e.g., a construction technology course may include examples that are applicable to plumbing, electrical/network cabling, masonry, heating and cooling, and carpentry).

The examples are intended as a guide for teachers rather than as an exhaustive or mandatory list. Teachers can choose to use the examples that are appropriate for their classrooms or they may develop their own approaches that reflect a similar level of complexity. Whatever the specific ways in which the requirements outlined in the expectations are implemented in the classroom, they must, wherever possible, be inclusive and reflect the diversity of the student population and the population of the province.

STRANDS IN THE TECHNOLOGICAL EDUCATION CURRICULUM

The overall and specific expectations for each course in the technological education curriculum are typically organized in four distinct but related strands. As students move up through the grades, the expectations within these strands will increase in complexity and depth. These strands are as follows:

Fundamentals: Students develop foundational knowledge and skills related to the design and fabrication of products or the provision of services in the particular broad-based technological subject area.

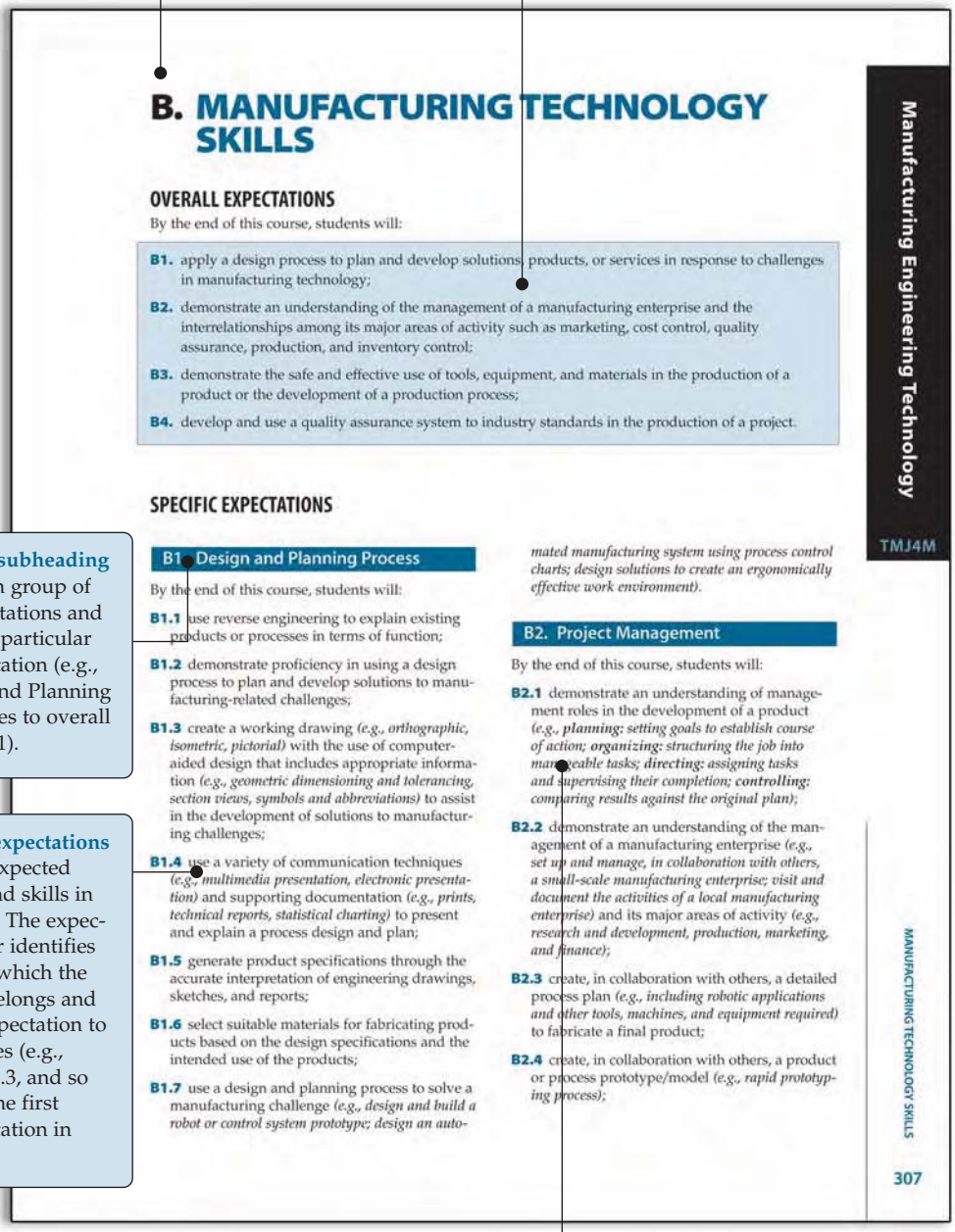
Skills: Students develop the technological skills required for responding to a variety of practical challenges.

Technology, the Environment, and Society: Students develop an understanding of the interrelationship between the technology or industry sector and the environment, and between the technology and various aspects of society. (In subject areas that relate to services, this strand is entitled Industry Practices, the Environment, and Society.)

Professional Practice and Career Opportunities: Students develop an understanding of health and safety standards in the industry, professional concerns and issues, and the Essential Skills and work habits valued in the sector, and explore career opportunities and the education and training required for them.

Technological education courses are typically organized into four **strands**, numbered A, B, C, and D.

The **overall expectations** describe in general terms the knowledge and skills students are expected to demonstrate by the end of each course. Two or more overall expectations are provided for each strand in every course. The numbering of overall expectations indicates the strand to which they belong (e.g., B1–B4 are the overall expectations for strand B).



B. MANUFACTURING TECHNOLOGY SKILLS

OVERALL EXPECTATIONS

By the end of this course, students will:

B1. apply a design process to plan and develop solutions, products, or services in response to challenges in manufacturing technology;

B2. demonstrate an understanding of the management of a manufacturing enterprise and the interrelationships among its major areas of activity such as marketing, cost control, quality assurance, production, and inventory control;

B3. demonstrate the safe and effective use of tools, equipment, and materials in the production of a product or the development of a production process;

B4. develop and use a quality assurance system to industry standards in the production of a project.

SPECIFIC EXPECTATIONS

B1. Design and Planning Process

By the end of this course, students will:

B1.1 use reverse engineering to explain existing products or processes in terms of function;

B1.2 demonstrate proficiency in using a design process to plan and develop solutions to manufacturing-related challenges;

B1.3 create a working drawing *(e.g., orthographic, isometric, pictorial)* with the use of computer-aided design that includes appropriate information *(e.g., geometric dimensioning and tolerancing, section views, symbols and abbreviations)* to assist in the development of solutions to manufacturing challenges;

B1.4 use a variety of communication techniques *(e.g., multimedia presentation, electronic presentation)* and supporting documentation *(e.g., prints, technical reports, statistical charting)* to present and explain a process design and plan;

B1.5 generate product specifications through the accurate interpretation of engineering drawings, sketches, and reports;

B1.6 select suitable materials for fabricating products based on the design specifications and the intended use of the products;

B1.7 use a design and planning process to solve a manufacturing challenge *(e.g., design and build a robot or control system prototype; design an automated manufacturing system using process control charts; design solutions to create an ergonomically effective work environment).*

B2. Project Management

By the end of this course, students will:

B2.1 demonstrate an understanding of management roles in the development of a product *(e.g., **planning:** setting goals to establish course of action; **organizing:** structuring the job into manageable tasks; **directing:** assigning tasks and supervising their completion; **controlling:** comparing results against the original plan);*

B2.2 demonstrate an understanding of the management of a manufacturing enterprise *(e.g., set up and manage, in collaboration with others, a small-scale manufacturing enterprise; visit and document the activities of a local manufacturing enterprise)* and its major areas of activity *(e.g., research and development, production, marketing, and finance);*

B2.3 create, in collaboration with others, a detailed process plan *(e.g., including robotic applications and other tools, machines, and equipment required)* to fabricate a final product;

B2.4 create, in collaboration with others, a product or process prototype/model *(e.g., rapid prototyping process);*

Manufacturing Engineering Technology

TMJ4M

MANUFACTURING TECHNOLOGY SKILLS

307

A **numbered subheading** identifies each group of specific expectations and relates to one particular overall expectation (e.g., "B1. Design and Planning Process" relates to overall expectation B1).

The **specific expectations** describe the expected knowledge and skills in greater detail. The expectation number identifies the strand to which the expectation belongs and the overall expectation to which it relates (e.g., B1.1, B1.2, B1.3, and so on, relate to the first overall expectation in strand B).

The **examples** help to clarify the requirement specified in the expectation and to suggest its intended depth and level of complexity. The examples are illustrations only, not requirements. They appear in parentheses and are set in italics.

PROBLEM SOLVING IN TECHNOLOGICAL EDUCATION

An approach to learning that emphasizes problem solving is the best way to prepare students for the challenges they will face in the world beyond school. In the workplace, projects or tasks may not always be clearly defined or have prescribed solutions. Students who have a strong background in problem solving will be more confident and better equipped to address new challenges in a variety of contexts.

Learning through problem solving will help students appreciate that all challenges – whether large or small, complex or simple – are most effectively resolved when approached systematically, using a simple method or a more comprehensive process, depending on the nature of the problem.

The range of challenges students encounter in technological education is wide and varied. At one end are simple problems for which there is likely to be only one solution – for example, substituting a part to fix an obvious fault. At the other end are complex challenges – for example, devising a solution to an identified human need – for which there could be various different solutions and which call for a detailed process that may involve consultations with stakeholders to clearly define the problem and determine criteria for its solution, and the design and testing of several potential solutions. In many cases, the nature of the problem, and the problem-solving process required to solve it, fall somewhere between these two extremes.

Technological education teachers can guide students through problem solving by helping them understand the nature and scope of a problem and the type of approach or method best suited to address it. They can also remind students that there is often more than one solution, give them the freedom to explore ideas, and encourage them to retrace steps and persist in their efforts when they encounter obstacles.

Problem-Solving Methods and Approaches

Problem-solving processes share at least some of a number of systematic steps – for example, identifying the problem, analysing the situation, considering possible solutions, selecting the best solution, testing and evaluating the effectiveness of the solution, and reviewing or repeating steps as necessary to improve the solution. Among the various problem-solving methods and approaches that may be employed to address the range of problems students will encounter in technological education are those listed below. This list is not comprehensive, and may be supplemented by various other methods in the classroom.

Parts Substitution

Perhaps the most basic of all the problem-solving methods, "parts substitution" simply requires that parts be substituted until the problem is solved. Although it is not the most scientific method of problem solving, there may be no other alternative if tests do not indicate what could be causing the problem.

Diagnostics

An example of a diagnostic problem-solving method is troubleshooting an engine fault in an automobile. After identifying the general problem, the technician would run tests to pinpoint the fault. The test results would be used either as a guide for further testing or for replacement of a part, which would also need to be tested. This process continues until the solution is found and the car is running properly.

Reverse Engineering

Reverse engineering is the process of discovering the technological principles underlying the design of a device by taking the device apart, or carefully tracing its workings or its circuitry. It is useful when students are attempting to build something for which they have no formal drawings or schematics.

Divide and Conquer

"Divide and conquer" is the technique of breaking down a problem into subproblems, then breaking the subproblems down even further until each of them is simple enough to be solved. Divide and conquer may be applied to allow groups of students to tackle subproblems of a larger problem, or when a problem is so large that its solution cannot be visualized without breaking it down into smaller components.

Extreme Cases

Considering "extreme cases" – envisioning the problem in a greatly exaggerated or greatly simplified form, or testing using an extreme condition – can often help to pinpoint a problem. An example of the extreme-case method is purposely inputting an extremely high number to test a computer program.

Trial and Error

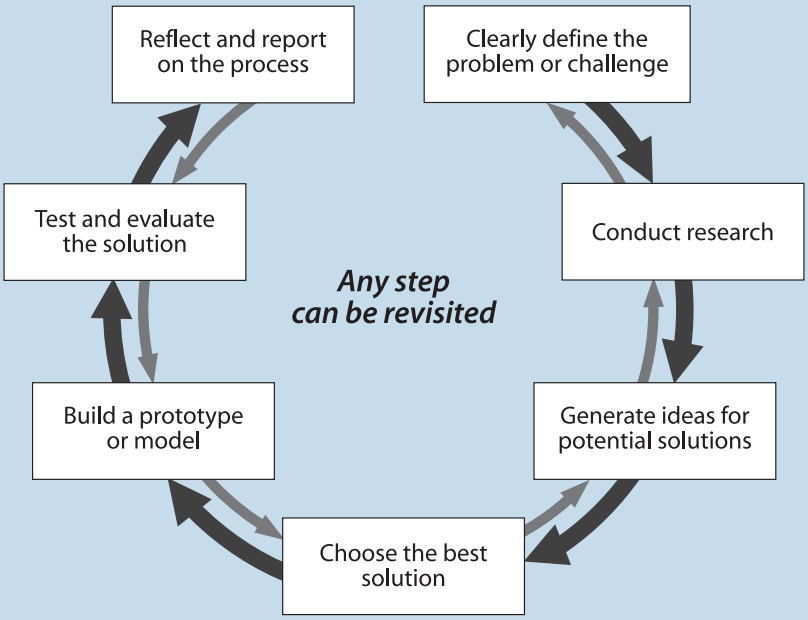
The trial-and-error method involves trying different approaches until a solution is found. It is often used as a last resort when other methods have been exhausted.

The Design Process

In many technological fields, open-ended problem-solving processes that involve the full planning and development of products or services to meet identified needs are often referred to as the "design process". A design process involves a sequence of steps, such as the following:

- Analyse the context and background, and clearly define the problem or challenge.
- Conduct research to determine design criteria, financial or other constraints, and availability of materials.
- Generate ideas for potential solutions, using processes such as brainstorming and sketching.
- Choose the best solution.
- Build a prototype or model.
- Test and evaluate the solution.
- Repeat steps as necessary to modify the design or correct faults.
- Reflect and report on the process.

Steps in the Design Process



Although processes such as this involve a framework of sequential steps, they are typically iterative processes that may require a retracing of steps, diversions to solve specific problems along the way, or even a return to the start of the process if it becomes clear that the situation needs to be clarified and the problem redefined. Problem solvers soon discover that the process calls for an open mind, the freedom to be creative, and a great deal of patience and persistence.