BIG IDEAS

Design for the life cycle includes consideration of social and **environmental impacts**.	Personal design interests require the evaluation and refinement of skills.	Tools and **technologies** can be adapted for specific purposes.

Learning Standards

Curricular Competencies	Content
Students are expected to be able to do the following: **Applied Design** ***Understanding context*** • Engage in a period of **user-centred research** and **empathetic observation** to understand design opportunities ***Defining*** • Establish a point of view for a chosen design opportunity • Identify potential users, intended impacts, and possible unintended negative consequences • Make decisions about premises and **constraints** that define the design space, and identify criteria for success • Determine whether activity is collaborative or self-directed ***Ideating*** • Critically analyze how competing social, ethical, and sustainability considerations impact creation and development of solutions • Generate ideas to create a range of possibilities and add to others' ideas in ways that create additional possibilities • Choose an idea to pursue based on success criteria and maintain an open mind about potentially viable ideas	*Students are expected to know the following:* • design for the life cycle • history of manufacturing and production • **product development** and **manufacturing processes** • manufacturing to meet the needs of the end user • **sustainable production**, upcycling, and **product life cycle** • **mathematics** in engineering projects • **measurement techniques** in engineering projects • **physics** in engineering projects • **static analysis** of structures • use of **hand tools** and **power tools** • **programming languages** for robotics and computer numerical control (CNC) • methods of implementing **computer control** • **technical communications** • approaches to **innovative engineering projects** • fundamentals of robotics and robotic manufacturing • **modelling** and **simulation**

Learning Standards (continued)

Curricular Competencies	Content
Prototyping • Choose a form for prototyping and develop a **plan** that includes key stages and resources • Analyze the design for the life cycle and evaluate its **impacts** • Visualize and construct prototypes, making changes to tools, materials, and procedures as needed • Record **iterations** of prototyping ***Testing*** • Identify and communicate with **sources of feedback** • Develop an **appropriate test** of the prototype, conduct the test, and collect and compile data • Apply information from critiques, testing results, and success criteria to make changes ***Making*** • Identify appropriate tools, technologies, materials, processes, cost implications, and time needed • Create design, incorporating feedback from self, others, and results from testing of the prototype • Use materials in ways that minimize waste ***Sharing*** • Decide how and with whom to **share** creativity, or share and promote design and processes • Share the product with users to evaluate its success • Critically reflect on plans, products and processes, and identify new design goals • Identify and analyze new possibilities for plans, products and processes, including how they or others might build on them **Applied Skills** • Apply safety procedures for themselves, co-workers, and users in both physical and digital environments	

Learning Standards (continued)

Curricular Competencies	Content
• Individually or collaboratively identify and assess skills needed for design interests • Demonstrate competency and proficiency in skills at various levels involving manual dexterity • Develop specific plans to learn or refine identified skills over time **Applied Technologies** • Explore existing, new, and emerging tools, technologies, and systems to evaluate suitability for design interests • Evaluate impacts, including unintended negative consequences, of choices made about technology use • Examine the role that advancing technologies play in multiple engineering contexts	

APPLIED DESIGN, SKILLS, AND TECHNOLOGIES – Engineering
Big Ideas – Elaborations
Grade 11

- **Design for the life cycle:** taking into account economic costs, and social and environmental impacts of the product, from the extraction of raw materials to eventual reuse or recycling of component materials
- **environmental impacts:** including manufacturing, packaging, disposal, and recycling considerations
- **technologies:** tools that extend human capabilities

APPLIED DESIGN, SKILLS, AND TECHNOLOGIES – Engineering
Curricular Competencies – Elaborations
Grade 11

- **user-centred research:** research done directly with potential users to understand how they do things and why, their physical and emotional needs, how they think about the world, and what is meaningful to them
- **empathetic observation:** aimed at understanding the values and beliefs of other cultures and the diverse motivations and needs of different people may be informed by experiences of people involved; traditional cultural knowledge and approaches; First Peoples worldviews, perspectives, knowledge, and practices; places, including the land and its natural resources and analogous settings; experts and thought leaders
- **constraints:** limiting factors, such as task or user requirements, materials, expense, environmental impact
- **plan:** for example, pictorial drawings, sketches, flow charts
- **impacts:** including social and environmental impacts of extraction and transportation of raw materials; manufacturing, packaging, and transportation to markets; servicing or providing replacement parts; expected usable lifetime; and reuse or recycling of component materials
- **iterations:** repetitions of a process with the aim of approaching a desired result
- **sources of feedback:** may include peers; users; First Nations, Métis, or Inuit community experts; other experts and professionals both online and offline
- **appropriate test:** includes evaluating the degree of authenticity required for the setting of the test, deciding on an appropriate type and number of trials, and collecting and compiling data
- **share:** may include showing to others or use by others, giving away, or marketing and selling

Content – Elaborations

- **product development:** stages of the engineering design process (e.g., feasibility analysis, conceptualization, preliminary design)
- **manufacturing processes:** for example, casting, molding, coating
- **sustainable production:** the creation of products using processes that are environmentally friendly and considering energy conservation and use of natural resources
- **product life cycle:** the process of managing the entire lifecycle of a product, from inception, through engineering design and manufacture, to service and disposal of manufactured product
- **mathematics:** for example, mathematical concepts and methods that support the computational aspect of engineering in terms of modelling, optimization, numerical analyses, and simulations
- **measurement techniques:** methods through which various quantities (such as force, displacement, velocity, acceleration, vibration frequency, strength, voltage, current, heat, electrical conductivity, or radio frequency) can be measured during the design and testing of a structure, mechanism, or material, to support the experimental aspect of engineering
- **physics:** ideas, principles, or concepts from physics that inform approaches to an engineering problem (e.g., Newtonian physics, forces, momentum, static equilibrium, dynamics, energy and energy conversions, electromagnetism, waves, optics, simple machines, electric circuits)
- **static analysis:** determining the effect of loads on static structures such as buildings, roads, and bridges, or on a frame, airframe, or chassis
- **hand tools:** for example, hammer, mallet, screwdriver, sanding block, chisel, pliers, ruler, square, hand saw
- **power tools:** for example, band saw, scroll saw, drill press, portable drill, belt and disk sander, mitre saw, soldering pen, power supply, thermoformer
- **programming languages:** for example:
  - in robotics: pictorial/block coding, C, python
  - in computer numerical control (CNC): G code
- **computer control:** for example, CNC, 3D printing, robotics
- **technical communications:** for example, sketching, technical drawing, computer-aided drafting (CAD), orthographic and pictorial drawings, technical reports, technical journals, end-user documentation, product manuals, catalogues
- **innovative engineering projects:** for example, CO_2 cars, magnetic levitation, desalination devices, electricity generation; alternative energy vehicles (such as cars, trucks, trains, and planes)
- **modelling:** using mathematical relations to describe a physical system
- **simulation:** using computations to imitate and predict how a physical system would work under various conditions, without conducting a lab experiment

