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:	*Students are expected to know 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*** • Identify and examine gaps for potential design improvements and innovations • 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 • Evaluate suitability of possibilities according to success criteria, constraints, and potential gaps, and prioritize for prototyping • Work with users throughout the design process	• design for the life cycle • **mathematics** in advanced engineering projects • **measurement techniques** in advanced engineering projects • advanced static analysis of structures: – stress-strain analysis – stress analysis software • **non-destructive testing** and destructive testing • materials science: – metals and alloys (metallurgy) – ceramics – plastics and polymers – composites • **geometric dimensioning and tolerancing** • vibrations and **seismic analysis** • programming languages and applications • quality control methods • **physics** in advanced engineering projects • robotics and robotic manufacturing

Learning Standards (continued)

Curricular Competencies	Content
Prototyping • Choose an appropriate form, scale, and level of detail for prototyping, and plan procedures • 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 • Evaluate design according to 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 and critically evaluate its success • Critically reflect on plans, products and processes, and identify new design goals • Evaluate 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	• future career options and opportunities in engineering, including design, production, and emerging applications • **interpersonal and consultation skills** for interacting with colleagues and clients

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 • Analyze the role that changing technologies play in multiple engineering contexts	

Big Ideas – Elaborations

APPLIED DESIGN, SKILLS, AND TECHNOLOGIES – Engineering Grade 12

- **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

Curricular Competencies – Elaborations

APPLIED DESIGN, SKILLS, AND TECHNOLOGIES – Engineering Grade 12

- **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
- **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

- **mathematics:** for example, mathematical concepts and methods that support the computational aspect of advanced engineering projects in terms of modelling, optimization, numerical analyses, and simulations
- **measurement techniques:** for example, 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 an advanced engineering project
- **non-destructive testing:** for example, evaluation of the properties of materials, components, or systems without causing damage
- **geometric dimensioning and tolerancing:** a system for defining and communicating engineering tolerances
- **seismic analysis:** for example, earthquake simulators, disaster relief shelters
- **physics:** ideas, rules, or concepts from physics that inform approaches to an engineering problem (e.g., kinematics, relative motion, dynamics, momentum and energy, electromagnetic forces and induction)
- **interpersonal and consultation skills:** for example, professional communications, collaboration, follow-ups, courtesies, record keeping, ways of presenting technical visuals to people who don't have a technical background