Module 1

Holistic Engineering for Impact: Integrating Systems Thinking, Social Responsibility, and Multidisciplinary Approaches

Institut Mines-Télécom Business School (IMTBS)

Co-funded by the European Union

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Module 1

Holistic Engineering for Impact: Integrating Systems Thinking, Social Responsibility, and Multidisciplinary Approaches

Learning Objective

Students will develop the ability to critically evaluate and design sustainable engineering solutions by applying systems thinking, integrating social responsibility, and drawing on multidisciplinary perspectives.

They will learn to recognize complex interconnections between environmental, social, and economic factors and respond with ethically informed, context-sensitive approaches.

This module explores how engineers can approach sustainability challenges through systems thinking, ethical responsibility, and multidisciplinary collaboration.

Students will examine real-world problems, assess trade-offs, and practice using tools and frameworks that promote socially just, environmentally responsible, and globally relevant engineering solutions.

Holistic Engineering for Impact

Module 1

Time Spent

The time that the student must dedicate to complete all levels of activities is between 5 hours and 15 minutes and 9 hours, if all levels of activities are completed.

	Competencies	Minutes	Minutes	Hours
Module 1	Competence 10	105 - 180		
	Competence 11	105 - 180	315 - 540	5, 15' - 9
	Competence 12	105 - 180		

The time that the student must dedicate to complete all levels of activities is between 5 hours and 15 minutes and 9 hours, if all levels of activities are completed.

Module Levels	Level 1 Basic	45' - 90'
	Level 2 Advanced	90' - 180'
	Integration Activity	180' - 270'

Competencies

C10: INTERCONNECTED ENVIRONMENT, SOCIETY AND ECONOMY

Ability to apply systems thinking in sustainability engineering by recognizing and addressing the interconnections between environmental, social, and economic factors, while designing solutions that remain within planetary boundaries and account for finite resource availability. *Students will learn to understand and respond to complex sustainability challenges by identifying the interconnections between environmental, social, and economic factors. Using tools like life-cycle analysis and systems mapping, they will assess trade-offs, anticipate unintended consequences, and design solutions that consider both immediate and long-term impacts across systems.*

C11: ETHICAL AND SOCIAL RESPONSIBILITY

Ability to integrate ethical and social responsibility into sustainability decisions by considering environmental justice, corporate accountability, and social equity. *Students will develop the ability to incorporate ethical and social responsibility into engineering decisions. They will explore topics such as environmental justice, corporate accountability, and social equity, learning to evaluate how engineering practices affect workers, communities, and vulnerable populations, and to design solutions that promote fairness and inclusivity.*

C12: CULTURAL AND MULTIDISCIPLINARY PERSPECTIVES

Ability to incorporate cultural and multidisciplinary perspectives in sustainability by integrating diverse viewpoints, including indigenous knowledge, to create globally relevant solutions. *Students will learn to integrate insights from fields beyond engineering - such as economics, sociology, and environmental science- to inform sustainable design. They will practice working with diverse perspectives to create solutions that are socially and culturally relevant, recognizing that complex global challenges require interdisciplinary approaches.*

Holistic Engineering for Impact

Module 1

Alignment with the SDGs

The competencies developed in this module are aligned with the following Sustainable Development Goals outlined in the 2020-2030 Agenda:

SDG 4 **Quality Education:** Ethical engineering education fosters critical thinking and sustainability literacy, empowering learners to make informed, responsible decisions for global challenges.

SDG 7 **Affordable and Clean Energy:** Ethical, systems-based approaches help design equitable and sustainable energy solutions that consider environmental, technical, and societal dimensions.

SDG 9 **Industry, Innovation and Infrastructure:** Critical systems thinking enables the development of sustainable and inclusive infrastructure that integrates ethical considerations and multidisciplinary innovation.

SDG 10 **Reduced Inequalities:** Engineering with a lens of social responsibility ensures that the benefits and impacts of technology are distributed fairly, addressing systemic inequities.

SDG 11 **Sustainable Cities and Communities:** Building ethical urban systems requires integrating diverse knowledge areas and ensuring that designs meet the needs of all communities, especially the most vulnerable.

SDG 12 **Responsible Consumption and Production:** Critical analysis of production systems and supply chains promotes ethical decision-making and supports circular, sustainable practices in engineering.

SDG 13 **Climate Action:** Addressing climate challenges demands systems thinking and ethical responsibility to ensure that engineering solutions are just, forward-thinking, and globally relevant.

SDG 16 **Peace, Justice, ad Strong Institutions:** Engineering practice grounded in ethics supports institutional integrity, transparency, and justice, essential for fostering peace and resilience.

SDG 17 **Partnerships for the Goals:** Solving complex sustainability issues requires interdisciplinary collaboration and ethical engagement across sectors, nations, and disciplines.

Holistic Engineering for Impact

Module 1

Skills and knowledge

Skills

14S PROBLEM SOLVING
Ability to solve complex problems.

15S CRITICAL
Critical thinking skills

16S FORESIGHT
Skills for strategic foresight & scenario planning

19S PARTICIPATION
Skills to generate stakeholder engagement, negotiation & conflict management

20S COLLABORATOR
Skills to collaboration with a range of stakeholders & disciplines

21S COMMUNICATION
Effective communication skills with a variety of audiences

16S SYSTEMIC
Skills to apply systems thinking

16S MULTIDISCIPLINARY
Skills to work with multidisciplinary approaches and environments

16S ETHICAL
Skills to include an ethical approach In problem solving

16S EMPATHY
Skills to understand users' needs and improve people's lives

Knowledge

01K BACKGROUND
Understanding the evolution of sustainability and the SDGs

02K SDGs
Connection between engineering and sustainability & the SDGs

04K GLOBAL
Geopolitical & economic influences on sustainability

07K SOCIETY
Applying sustainability and social systems in the real world

10K BEST PRACTICES
Knowing real engineering projects in whose process sustainability is present

Holistic Engineering for Impact

Module 1

Matrix Table

Competences, Skills & Knowledge

Transversal Skills		C10	C11	C12
PROBLEM SOLVING	S14			
CRITICAL	S15			
Knowledge		**C10**	**C11**	**C12**
BACKGROUND	K01			
SDGs	K02			
LIMITS	K03			
THEREATS	K05			
SOCIETY	K07			

Holistic Engineering for Impact

Module 1

Teaching methodologies applied in this module:

This module uses interactive and inquiry-driven teaching methods to help students develop key sustainability competencies in engineering: systems thinking, ethical and social responsibility, and the ability to work across disciplines. Through activities such as case analysis, problem-solving, role-play, and guided research, students will explore complex real-world challenges and practice integrating environmental, social, and economic considerations. The goal is to prepare students to design thoughtful, responsible solutions that reflect the interconnected nature of sustainability.

Reflective Learning:
Supports personal and ethical growth by encouraging students to examine their values, assumptions, and the broader impacts of engineering decisions.

Peer Learning:
Enhances understanding through the exchange of diverse perspectives, encouraging collaboration and cross-disciplinary insight.

Systems Thinking Exercise:
Builds the ability to recognize patterns, feedback loops, and interdependencies within sustainability challenges.

Gamification:
Engages students through interactive scenarios that simulate real-world trade-offs, reinforcing decision-making in complex systems.

Inquiry-Based Learning:
Develops independent thinking by prompting students to explore sustainability issues through guided research and questioning.

Socratic Debate:
Sharpens ethical reasoning and argumentation skills through structured dialogue on contested sustainability topics.

Case-Based Learning:
Encourages contextual analysis of engineering decisions, emphasizing real-world consequences and stakeholder perspectives.

Role-Play:
Immerses students in multiple stakeholder roles to practice empathy, ethical judgment, and negotiation in sustainability contexts.

Simulation:
Offers experiential learning in dynamic systems, helping students explore long-term impacts and ethical complexities of engineering decisions.

Web Quests:
Guides students in seeking and evaluating interdisciplinary information, strengthening research skills across technical and social domains.

Guided Inquiry:
Combines structure and autonomy to support exploration of sustainability issues through multiple lenses, including social equity and environmental impact.

Problem-Based Learning:
Promotes collaborative problem-solving on open-ended challenges, integrating systems thinking, ethics, and interdisciplinary perspectives.

Holistic Engineering for Impact

Matrix Table

Pedagogies

Pedagogical Teaching		C10	C11	C12
Problem-Based Learning (PBL)	P01		■	■
Case-Based Learning	P02	■	■	■
Design Thinking	P03		■	
Role-Play and Simulation	P04	■	■	■
Microlearning	P09	■	■	
Digital Storytelling	P11			■
Challenge-Based Learning	P14	■		■
Peer Learning / Peer Review	P15			■
Project-Based Learning	P16	■		
Reflective Practice / Learning Journals	P19	■		
Systems Thinking Exercises	P20	■		■

C10: Interconnected Environment, Society & Economy

Module 1

Learning Outcomes

After completing the basic activities, students will be able to explain the interconnectedness between human action and global social and environmental impacts (both positive and negative), as well as how human-made designs and actions both rely upon and are embedded within ecological and social systems.

Upon completing the advanced activities, students will be able to identify and apply relevant concepts from required disciplines to the study of real-world problems and their solutions with empathic and ethical consideration for communities/societies, environmental justice, and cultural awareness.

Skills

PARTICIPATION

CRITICAL

PROBLEM-SOLVING

SYSTEMIC

ETHICAL

Knowledge and Understanding

SDGs

ENVIRONMENTAL

SOCIETY

THREATS

C10: Interconnected Environment, Society & Economy

Activity 1_Level Basic: An Introduction to Systems Design and Whole Life Cycle Thinking

INTRODUCTION

Through this activity, students will learn to understand the interconnectedness of human actions with environmental and social systems. Using a Whole System Mapping design method, students are introduced to systems-level thinking and new methods for measuring impact.

INSTRUCTION FOR THE STUDENTS

1. **Watch the video "Whole Systems Design:** Introduction to Life Cycle Thinking" introducing systems thinking (6 minutes)

M1_C10_A1_R1_T1

2. **Discuss your findings as a class,** building off your instructor's discussion questions.

DESCRIPTION (15 - 30 min)

Begin by having your students watch the **"Whole Systems Design: Introduction to Life Cycle Thinking"** introducing systems thinking (6 minutes). Prompt discussion as a class by asking questions such as:

1. The video introduces the concept of looking at the whole system. Using the clothes dryer example, what does the video show us is included in the "system" beyond just the dryer itself? Why is expanding the definition of the problem to include the larger system (like how clothes get dirty, washed, and dried) so important for finding sustainable solutions?

   This question prompts students to recall how the system boundary is expanded and the rationale for doing so.

2. The video emphasizes considering the entire life cycle of a product or service. What are the stages of a product's life cycle mentioned in the video that have environmental impacts? According to the video, how does looking at the full life cycle, perhaps using a method like Life Cycle Assessment (LCA), help engineers determine where to focus their efforts for sustainability improvements?.

   This question highlights the life cycle concept and its utility in prioritizing efforts based on impact.

3. The video suggests that looking at the whole system and life cycle can lead to more innovative solutions. Can you describe the specific example given where the solution for a more sustainable dryer was actually found by changing the washing machine? Why did thinking about the system beyond the dryer lead to this kind of solution, and what other types of "radical" ideas did the video suggest could come from this broad thinking?

   This question connects the concepts of system and life cycle thinking to the generation of non-obvious and potentially radical innovations.

C10: Interconnected Environment, Society & Economy

Activity 2_Advanced Whole System Mapping

INTRODUCTION

In this lesson, students will learn how to use Whole System Mapping to identify sustainability opportunities within a product's full life cycle and context. By analysing system elements, setting priorities, and mapping solutions, students will practice applying systems thinking to develop innovative and responsible engineering designs.

INSTRUCTION FOR THE STUDENTS

1. **Watch the video "Whole System Mapping** – Deep Dive" (30 minutes).

M1_C10_A2_R1_T2

2. **Discuss your findings as a class**, building off of your instructor's discussion questions.

DESCRIPTION (45-60 min)

Begin by having your students watch the video on Whole System Mapping (30 minutes). Prompt discussion as a class, or separate students into groups to discuss questions such as (15-30 minutes):

- According to the video, what is the overall purpose of Whole System Mapping, and how can it help turn sustainability from a burden into an innovation tool?
- Looking at the first activity, "Draw the system map," what different types of elements (beyond just the physical parts or 'bill of materials') are included in the map for a product like the refrigerator example? Why is it important to include things like the full life cycle (from raw materials to end of life), user interaction, and other things the product is used with?
- The video emphasizes adding connections (arrows) to the system map. What do these connections represent in the refrigerator example, and why do you think showing these links is valuable for understanding the system?
- Moving to the second activity, "Set priorities," the video recommends using tools like LCA. What information does LCA or similar scorecards provide that helps in this step?

The video also highlights setting different types of priorities, such as sustainability priorities and business or user priorities. Why is it important to consider both types together?

- In the third activity, "Brainstorm solutions on the system map," how does placing ideas directly onto the map help make the brainstorming both more "thorough" and more "radical"? Can you recall an example from the video of an idea that was considered "radical," and how it was related to eliminating parts of the system map?
- Finally, in the "Decide on winners" phase, how are the priorities set earlier in the process used to evaluate the brainstormed ideas? The video shows using a decision matrix. What are the key pieces of information included in this matrix (besides the ideas themselves), and how does it help compare potential solutions?
- The video notes that the decision matrix is a tool to aid critical thinking, not something to follow "slavishly". Based on the examples given (like the glass door or vacuum panel insulation), what are some factors that might make you question the initial scores in the matrix or lead you to combine different ideas?

If desired, assign students one or more of the above questions as homework.

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Activity 3_Integrated Activity Whole System Mapping in Practice

INTRODUCTION

In this activity, students will work in groups to apply Whole System Mapping to a real product or service. They will visually map the system, identify key priorities using life cycle thinking, brainstorm potential improvements, and evaluate solutions based on sustainability goals. This hands-on activity builds systems thinking skills and helps students design more innovative and responsible engineering solutions.

INSTRUCTION FOR THE STUDENTS

M1_C10_A3_R1_T3

1. If you haven't already, watch the video on Whole System Mapping– Deep Dive (30 minutes, optional)
2. Create a map of a product or service
3. Use a Life Cycle Assessment to set an environmental, economic, or social priority (e.g., reduce the environmental cost of a construction project), and balance it with the other two.
4. Brainstorm on the developed system map to encourage thorough and radical ideation.
5. Share with your class and vote on a winning system map

DESCRIPTION (60-90 min)

Break the class into groups to perform a Whole System Mapping exercise. If you haven't already shown the Deep Dive video, show it first (30 minutes). Alternatively, explain Whole System Mapping to students.

M1_C10_A3_R1_T4

Begin with either a description of the **Whole System Mapping method**, or use the video provided to introduce it for you. The four steps to the mapping exercise are (30-60 minutes):

1. Visually map the product or service's system
2. Use a Life Cycle Assessment to set an environmental, economic, or social priority (e.g., reduce the environmental cost of a construction project), and balance it with the other two.
3. Brainstorm on the developed system map to encourage thorough and radical ideation.
4. Choose a winning idea based on course priorities and your estimation of idea performance.

Depending on the flexibility of your course, this exercise can be condensed into a single 30-60 minute period, or extended as a longer integration activity spanning up to 90 minutes (see above). You may also assign the initial brainstorming activity in the Level 1 - Basic section as a homework task to be discussed in the following class period. The Whole System Mapping exercise may also be assigned outside of class as a homework or project

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Module 1

Applied teaching pedagogies:

Pedagogies for Level 1 _Basic activity

OP1 Reflective Learning

OP2 Peer Learning

Pedagogies for Level 2_ Advanced activity

16P Systems Thinking Exercises

Pedagogies Level 3_ Integration activity

03P Systems Thinking Exercises

14P Peer Learning

16P Gamification

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Module 1

Direct References:

Level 1 _Basic activity:

- YouTube Video: "Whole Systems Design: Introduction to Life Cycle Thinking": https://www.youtube.com/watch?v=7mC9xaJC2dQ
- Ercan, M. F., & Caplin, J. (2017, December). Enabling systems thinking for engineering students. In 2017 IEEE 6th International Conference on Teaching, Assessment, and Learning for Engineering (TALE). IEEE. https://doi.org/10.1109/TALE.2017.8252294
- Mobus, G. E. (2018). Teaching systems thinking to general education students. Ecological Modelling, 373, 13–21. https://doi.org/10.1016/j.ecolmodel.2018.01.013

Level 2_ Advanced activity:

- YouTube Video: "Whole System Mapping - Deep Dive": https://www.youtube.com/watch?v=Bv7p_RF3o5s
- Ercan, M. F., & Caplin, J. (2017, December). Enabling systems thinking for engineering students. In *2017 IEEE 6th International Conference on Teaching, Assessment, and Learning for Engineering (TALE).* IEEE. https://doi.org/10.1109/TALE.2017.8252294
- Mobus, G. E. (2018). Teaching systems thinking to general education students. Ecological Modelling, 373, 13–21. https://doi.org/10.1016/j.ecolmodel.2018.01.013

Level 3_ Integration activity

- YouTube Video: "Whole System Mapping - Deep Dive": https://www.youtube.com/watch?v=Bv7p_RF3o5s
- Whole System Mapping Exercise: https://venturewell.org/tools_for_design/whole-systems-mapping/whole-systems-mapping-exercise/
- Ercan, M. F., & Caplin, J. (2017, December). Enabling systems thinking for engineering students. In *2017 IEEE 6th International Conference on Teaching, Assessment, and Learning for Engineering (TALE).* IEEE. https://doi.org/10.1109/TALE.2017.8252294
- Mobus, G. E. (2018). Teaching systems thinking to general education students. Ecological Modelling, 373, 13–21. https://doi.org/10.1016/j.ecolmodel.2018.01.013

C10: Interconnected Environment, Society & Economy

Level I Assessment - Basic

Answer all the questions that follow:

1. ***True or False: According to the video, whole systems and life cycle thinking are the two most important global principles of sustainable design.***

2. ***According to the video, what is the first step before fixating on final design solutions?***
   a) Brainstorming innovative ideas.
   b) More deeply defining the problem by looking at the whole system.
   c) Comparing potential solutions against criteria. d) Quantifying environmental impacts with LCA.

3. ***True or False: In the clothes dryer example, looking at the "whole system" involves expanding the thinking to include the larger process of clothes getting dirty, being washed, and being dried***

4. ***True or False: The video suggests that getting perspectives from people like marketing or manufacturing experts is helpful for understanding and bounding the design problem***

5. ***Which of the following is NOT listed in the video as a stage in a product's life cycle that has environmental impacts?***
   a) Manufacturing
   b) Distribution
   c) Marketing
   d) Use
   e) Disposal

6. **According to the video, what is the most thorough way to measure environmental impacts through the entire life cycle?**
   a) Brainstorming solutions.
   b) Setting priorities based on cost.
   c) Life Cycle Assessment (LCA).
   d) Getting perspectives from users.

Level I Assessment - Basic

Answer all the questions that follow:

7. ***In the clothes dryer example discussed in the video, where did the analysis find the most opportunity for environmental improvement?***

a) Reducing waste during disposal.
b) Using fewer raw materials during manufacturing.
c) Reducing energy used during the life of the dryer.
d) Decreasing water pollution during washing.

8. ***True or False: Looking again at the whole system can help find innovative solutions, such as the example where changing the washing machine helped save energy for the dryer***

9. ***Which of the following is given in the video as an example of a "drastic innovation" that could come from thinking broadly about the clothes drying system?***

a) Making the dryer's heating system more efficient.
b) Using less water in the washing machine.
c) Eliminating the dryer altogether in favour of a next generation clothes-line.
d) Improving the distribution network for dryers.

10. ***True or False: When choosing between potential solutions, the video recommends assessing them against criteria such as cost, performance, environmental, and social impact***

C11: Ethical & Social Responsibility

Module 1

Learning Outcomes

Upon completing the Basic Activities, students will have the capacity to recognise, consider and be empathetic to ethical implications relative to the social and environmental impact of solutions to real-world problems. Students will be able to describe how engineering activities directly and indirectly cause positive and negative social/ cultural impacts throughout the design life-cycle, both to workers producing the products (i.e., labour practices, livelihood, health, etc.) and to communities, society, and non-human life (i.e., resources acquisition, waste production and management, traditional/cultural methodologies, etc.). Students will be able to identify and describe the main components of the SA8000 standard.

Upon completing the Advanced Activities, students will be able to understand the implications of ethics-based policies at the regional, national, and global levels, and consider ethics beyond current environmental compliance and political boundaries. Additionally, they will be able to demonstrate awareness of alternative forms of capital beyond financial resources (including natural, human, social, and physical) and awareness of emerging economic systems intended to promote environmental and social responsibility in economic thinking (e.g., Doughnut Economics, circular economy, etc.)

Skills

EMPATHY

CRITICAL

PROBLEM-SOLVING

ETHICAL

Knowledge and Understanding

ENVIRONMENTAL

BACKGROUND

SOCIETY

GLOBAL

C11: Ethical & Social Responsibility

Module 1

Activity 1_Level Basic
Engineering and its Broader Impact

INTRODUCTION

Students will begin to understand different approaches to economic systems and growth. They will be prompted to consider engineering's impact on economic systems, and therefore in turn social and environmental systems.

INSTRUCTION FOR THE STUDENTS

1. **Watch the TED Talk by Kate Raworth** M1_C11_A1_R1_T5
2. **Engage in the group discussion**, following your instructor's discussion questions

DESCRIPTION (15 - 30 mins)

Show students the TED Talk by Kate Raworth. Prompt discussion as a class by asking any of the questions below, or your own:

Shifting the Goal: From Growth to Thriving: The video challenges the traditional idea of economic progress as an "ever-rising line of growth", arguing that economies need to be designed to "make us thrive whether or not they grow". Raworth suggests this is a "profound shift in mindset" needed for humanity to thrive this century.

- **Question:** As engineers, much of our work is often implicitly or explicitly linked to facilitating economic growth (e.g., building larger infrastructure, developing technologies for mass consumption, increasing efficiency for higher output). How might the engineering design process, project selection, or material choices change if the primary goal was shifted to enabling societal thriving – meeting human needs within planetary boundaries – instead of maximizing traditional economic growth? What ethical considerations does this shift introduce for engineers?

Engineering within the Doughnut: Raworth introduces the Doughnut model, representing a space where humanity can thrive by meeting the "social foundation" of human needs without overshooting the "ecological ceiling" of planetary boundaries. She notes that currently, humanity is falling short on basic needs and overshooting planetary limits.

- Question: Think about engineering's impact through the lens of the Doughnut. How do engineering activities (past and present) contribute to either falling short of the social foundation (e.g., access to clean water, energy, housing) or overshooting the ecological ceiling (e.g., causing climate breakdown, pollution, resource depletion)? What specific responsibilities do engineers have in designing solutions that help humanity stay within this safe and just space, addressing both the shortfall and the overshoot simultaneously?

C11: Ethical & Social Responsibility

Activity 1_Level Basic
Engineering and its Broader Impact

DESCRIPTION (PART 2)

Regenerative Engineering Design:

The video argues that 21st-century economies must be "regenerative by design", moving away from degenerative linear processes of 'take-make-use-throw away' towards working with nature's cycles where resources are used again and again. Examples include renewable energy and circular city design.

- Question: How can the principles of regenerative design be applied within your specific engineering discipline (e.g., materials engineering, civil engineering, mechanical design)? What are the ethical motivations and challenges involved in designing systems, products, or infrastructure that minimize waste, utilize renewable resources, and fit within natural cycles? How does this contrast with ethical considerations in traditional, linear design?

Distributive Engineering Design:

Raworth also calls for economies to be "distributive by design", using technologies and institutions to distribute wealth, knowledge, and empowerment more broadly, contrasting with 20th-century centralized models. She mentions renewable energy networks, digital platforms, and 3D printing as examples of potentially more distributive technologies.

- **Question:** How can engineers design technologies, systems, or products to be inherently more distributive, sharing benefits, access, or knowledge more equitably among people and communities? What ethical responsibilities do engineers have to consider the social and economic impacts of their designs regarding equity and access?

Navigating Societal Addictions to Growth:

The talk highlights societal addictions to growth – financially, politically, and socially. These addictions influence investment, policy, and consumer behaviour.

- **Question:** How might these societal addictions to growth create ethical dilemmas or pressures for engineers in their professional lives? For instance, accepting projects that are profitable but environmentally damaging, or designing products with planned obsolescence to drive consumption? How can engineers exercise social responsibility when faced with pressures to prioritize growth over the regenerative and distributive goals of a thriving economy?

Boundaries as Innovation Drivers:

Raworth argues that boundaries, like the ecological and social limits in the Doughnut, are not just constraints but can "unleash our potential" for "boundless creativity".

- **Question:** How can engineering students view and utilize the environmental and social boundaries discussed in the video (e.g., limited resources, climate targets, basic human needs) as drivers for innovation and creativity in their design processes, rather than solely as limitations? Can you think of engineering challenges where working within strict boundaries has historically led to more innovative, efficient, or ethically sound solutions?

These questions are designed to provoke discussion by directly referencing concepts and terminology from the video ("thrive, not grow," "Doughnut," "regenerative design," "distributive design," "addictions to growth," "boundaries as creativity") and explicitly asking students to connect them to their field of engineering, considering both technical approaches and ethical implications.

Activity 2_Advanced
Social Accountability and the SA8000 Standard

INTRODUCTION

In this activity, students are introduced to the concept of social responsibility in engineering, focusing on how technical decisions can impact workers, communities, and the environment across the product lifecycle. The SA8000 standard is presented as a practical framework for understanding ethical labour practices. By exploring its nine core areas, students will begin to consider how engineers can contribute to socially responsible and ethically sound solutions in real-world contexts.

INSTRUCTION FOR THE STUDENTS

1. Review the **Social Accountability 8000 (SA8000) standard** framework and the **SA8000 Guidance Document**.

   M2_C11_A2_R1_T6 M1_C11_A2_R2_T7

2. Engage in the group discussion, following your instructor's discussion prompts

DESCRIPTION (40 - 60 mins)

Begin by briefly introducing the concept of social responsibility and ethical considerations specifically for engineers (20-30 minutes). Explain that engineering solutions have impacts far beyond technical function - they affect people, communities, and the environment throughout their lifecycle and supply chain. Introduce the **Social Accountability 8000 (SA8000) standard** as a widely recognized framework for social accountability in workplaces, addressing ethical labour practices. Note that this standard provides a concrete way to understand and address some of these social impacts. Present or share the link to the **SA8000 Guidance Document**. Explain that this document provides background, requirements, and guidance for implementing the standard.

Quickly go through the nine core categories covered by SA8000:

1. Child labour
2. Forced or compulsory labour
3. Health and safety
4. Freedom of association and right to collective bargaining
5. Discrimination
6. Disciplinary practices
7. Working hours
8. Remuneration
9. Management system

Briefly explain that while the first eight points cover specific social performance criteria, the ninth, the Management System, is crucial as it provides the framework for organizations to identify, assess, and manage risks and ensure continual improvement in social performance.

C11: Ethical & Social Responsibility

Activity 2_Advanced
Social Accountability and the SA8000 Standard

DESCRIPTION (PAGE 2 – Discussion)

Guided Discussion:
Connecting SA8000 to Engineering (20 - 30 minutes)

Transition to a discussion phase. Encourage students to think critically about how these standards relate to their future roles as engineers. Have the students break into groups to discuss different prompts below, or facilitate the discussion for the entire class using the following prompts or those of your own, allowing students time to consider and respond. You can structure this by focusing on one or two key areas from the standards at a time and linking them to engineering activities.

Discussion Prompt 1
(Focus: Health & Safety, Design & Manufacturing):

- “Let's look at SA8000 Section 3: Health and Safety. The standard requires providing a safe workplace and taking steps to prevent incidents and minimize hazards based on current knowledge. As engineers, you might design machinery, processes, or facilities. How do the requirements to identify, assess, and minimize/eliminate workplace hazards directly influence your engineering design decisions?"
- "Think about the design phase of a product or a factory layout. How might you design equipment to be inherently safer for workers? How do choices about materials or manufacturing processes relate to potential worker health risks (e.g., chemical exposure, ergonomics)?"
- “SA8000 Section 7: Working Hours also links to health and safety, noting that long hours increase accident rates. How might engineering decisions related to production targets or automation impact the working hours required of human operators, and thus their safety and well-being?"
- **Other possible points for discussion**: Designing in safety guards, considering ergonomic factors, selecting less hazardous materials, automating repetitive or dangerous tasks, impact of production efficiency requirements on worker pace/stress.

Discussion Prompt 2
(Focus: Supply Chains, Global Impact & Remuneration):

- "SA8000 puts a strong emphasis on managing suppliers and contractors (Section 9.10) and addressing issues like Child Labour, Forced Labour, and ensuring Remuneration meets a living wage (Section 8) within the supply chain."
- "Most engineered products rely on complex global supply chains for materials and components. How does the requirement for organizations to conduct due diligence on their suppliers and encourage socially accountable practices push engineers to think about the ethical implications beyond the technical specifications or cost of a component?
- "How does considering issues like child labour, forced labour, or fair wages in a supplier's factory in a different country challenge you to think about ethical responsibilities that might go beyond your own national laws or standard environmental compliance?
- "What are the practical engineering implications of demanding ethical sourcing? (e.g., material selection based on origin, requiring supplier certifications like SA8000, designing for simpler supply chains)."
- **Other possible points for discussion:** Traceability of materials, selecting suppliers based on social audits, designing with locally sourced materials, the complexity of ensuring fair labour practices far down the supply chain.

Activity 2_Advanced. Social Accountability and the SA8000 Standard

DESCRIPTION (PAGE 3 – Discussion and Wrap-up)

Discussion Prompt 3
(Focus: Management Systems, Risk Assessment & Proactive Ethics):

- "SA8000's Management System (Section 9) requires things like Risk Assessment (9.3), Corrective and Preventive Actions (9.8), and Internal Involvement/Communication (9.5). It aims for a proactive approach to social performance."
- "This isn't just for management; it's meant to involve 'all personnel'. As engineers, you are often involved in identifying technical risks. How can the principles of SA8000 encourage you to think about identifying and assessing potential social or ethical risks ... associated with your projects, designs, or processes before they cause harm?"
- "Consider things like the social impact of automating jobs, the ethical implications of using certain data or AI, or the potential environmental justice issues related to where resources are extracted, or waste is managed. How can engineers use their problem-solving skills to contribute to a management system that identifies and mitigates these broader social risks?"
- "How does this proactive, system-based approach to ethics differ from simply reacting to problems or complying with minimum legal standards? [Advanced Outcome]"
- **Other possible points for discussion:** Engineers bringing forward concerns about project impacts, participating in cross-functional ethics committees, designing processes with built-in social impact checks, using risk assessment tools that include social criteria.

Wrap-up (5 - 10 minutes)
Briefly summarize the key points discussed, reinforcing that social responsibility and ethical considerations, as exemplified by standards like SA8000, are integral to engineering practice.

Reiterate that engineers have a significant role to play in ensuring positive social impacts, not only through technical competence but also by being mindful of the human element in design, production, and supply chains, and by contributing to ethical practices within their organizations and beyond conventional boundaries.

C11: Ethical & Social Responsibility

Activity 3_Integrated Activity
Ethics & Social Accountability in Practice

INTRODUCTION

Students will learn to assess engineering decisions using the five capitals framework and alternative economic models like Doughnut Economics and the Circular Economy. They will examine how these tools help identify social and environmental risks, apply ethical standards such as SA8000, and explore ways to redesign engineering practices to be more regenerative, distributive, and socially responsible.

INSTRUCTION FOR THE STUDENTS

1. Learn about the **Multiple Capitals** and **Emerging Economic Models** frameworks.

M1_C11_A3_R1_T10 | M1_C11_A3_R2_T11

2. Review the case study and analyse it with your group. Use the attached discussion questions to guide you.
3. As a group, share your findings with the class and engage in the group discussion.

DESCRIPTION (60-90 min)

Introduction & Recap (5 minutes)

State the session's learning outcome focusing on multiple capitals and alternative economic models in engineering practice, in order to minimize negative environmental and social impact. **If you conducted the previous activities with students, prompt them to recall key concepts from previous sessions, or ask more general questions about key topics including:**

- Social/environmental impacts of engineering (core outcome)
- SA8000 principles (e.g., Health & Safety, Management System responsibilities)
- Core ideas from Kate Raworth's Doughnut Economics (social foundation, ecological ceiling, regenerative/distributive design)

Introduce the 2 frameworks (10 minutes)

Documents related to both of these frameworks are linked above, and website links are included in Additional Resources. The websites are good for a quick general overview.

- **Multiple Capitals:** Briefly re-introduce or define: Natural, Human, Social, Physical/Manufactured, and Financial capital. Emphasize seeing engineering projects through these multiple lenses.
- **Emerging Economic Models:** Briefly revisit Doughnut Economics and Circular Economy as frameworks aiming for sustainability and social responsibility. Highlight the goal of genuine regeneration and equitable distribution vs. purely linear or profit-driven models.

Case Study Analysis - Group Work (30-40 min)

Present Case: Introduce the specific online case study: "Recycled materials and the circular economy." Briefly set the scene involving Charlie, the junior environmental engineer at Circle Mat, a company recognized for using recycled materials but facing potential contamination issues. Ensure students read/have access to the case details.

M1_C11_A3_R3_T12

Activity 3_Integrated Activity
Ethics & Social Accountability in Practice

DESCRIPTION (PAGE 2)

Group Task:

Divide students into small groups (3-5). Ask them to analyse the Circle Mat case using the following guiding questions:

Capital Impacts & Dependencies

Identify how Circle Mat's operations impact or depend on each of the five capitals:

- **Natural:** What resources are used? What are the potential pollution/contamination risks (asbestos)?
- **Human:** Consider Charlie's ethical stress/career risk, potential worker exposure, public health risks, skills involved.
- **Social**: Think about community perception (prosperity vs. safety), public trust, the company's reputation, the value of the sustainability award.
- **Physical**: What are the implications for the buildings using Circle Mat's products?
- **Financial**: Consider company profits, the value of the award, costs of proper testing vs. potential liability costs.
- What are the key trade-offs being made (e.g., profit/reputation vs. safety/environmental protection)?

Applying Alternative Economics:

- How does Circle Mat's approach align with or contradict genuine Circular Economy principles? Is it true recycling/upcycling or potentially harmful downcycling?
- Analyse the situation using Doughnut Economics: Is Circle Mat helping society stay within the 'safe and just space'? Where are the potential ecological ceiling overshoots (pollution) or social foundation shortfalls (health, safety, potentially decent work)?
- How could Circle Mat's process or business model be redesigned to be more genuinely regenerative and distributive?

Ethical & Social Responsibility (linking to previous learning):

- What are the specific ethical dilemmas faced by Charlie? What about her supervisor, Sam?
- How do the requirements of SA8000 (Sec 3: Health & Safety; Sec 9: Management System, esp. Risk Assessment 9.3, Corrective Actions 9.8) apply here? Is Circle Mat's management system functioning effectively regarding social/environmental risk?
- What are the broader implications for Corporate Social Responsibility (CSR) and greenwashing?

Activity 3_Integrated Activity Whole System Mapping in Practice

DESCRIPTION (PAGE 3)

Group Sharing & Facilitated Discussion (15-25 min)

Ask each group to share key findings, focusing on different aspects (e.g., one group on capitals, another on Doughnut/Circular analysis, another on ethical/SA8000 links). Facilitate a broader discussion using prompts related to the case:

- What are the pressures Charlie is facing? What options does she have? What would you do in her situation?
- How does the focus on winning a sustainability award potentially conflict with genuine sustainable practices?
- How does considering the five capitals provide a richer understanding of the situation than a purely technical or financial analysis?
- What systemic changes (within the company, industry, or regulation) could prevent situations like this?
- How can engineers effectively raise concerns about ethical or safety issues within an organization?

Wrap-up & Synthesis (5 min)

Summarize the key discussion points, highlighting how the Circle Mat case illustrates the complexities of applying sustainability principles (like circular economy) in practice and the importance of considering multiple capitals and ethical frameworks.

Reiterate the value of Doughnut Economics and multi-capital thinking for engineers aiming to integrate social responsibility (Competence C21).

Briefly confirm the achievement of the learning outcome through the case analysis and discussion.

C11: Ethical & Social Responsibility

Module 1

Applied teaching pedagogies:

Pedagogies for Level 1 _Basic activity

OP1 Inquiry-Based Learning

OP2 Socratic Debate

Pedagogies for Level 2_ Advanced activity

16P Inquiry-Based Learning

02P Socratic Debate

Pedagogies Level 3_ Integration activity

03P Case-Based Learning

C11: Ethical & Social Responsibility

Direct References:

Level 1 _Basic activity:

- Kate Raworth's Ted Talk: "A healthy economy should be designed to thrive, not grow": https://www.ted.com/talks/kate_raworth_a_healthy_economy_should_be_designed_to_thrive_not_grow/transcript
- About Doughnut Economics | DEAL
- Raworth, K. (2017). *Doughnut economics: Seven ways to think like a 21st-century economist*. Chelsea Green Publishing.
- van de Poel, I., & Royakkers, L. (2023). *Ethics, technology, and engineering: An introduction* (2nd ed.). John Wiley & Sons.

Level 2_ Advanced activity:

- Social Accountability 8000, International Standard by Social Accountability International (June 2014) https://venturewell.org/wp-content/uploads/SA8000-Standard-2014.pdf
- SA8000 Guidance Document https://venturewell.org/wp-content/uploads/SA8000-2014-Guidance-Document-May-2016.pdf
- SA8000 Labor Certification – Measuring Sustainability https://venturewell.org/tools_for_design/measuring-sustainability/sa8000-certification/
- Johnson, D.G. (2017). Rethinking the Social Responsibilities of Engineers as a Form of Accountability. In: Michelfelder, D., Newberry, B., Zhu, Q. (eds) Philosophy and Engineering. Philosophy of Engineering and Technology, vol 26. Springer, Cham. https://doi.org/10.1007/978-3-319-45193-0_7
- Costa, A., Ribeiro, J.L., Gomes, D. (2020). Development of Policies and Practices of Social Responsibility in Portuguese Companies: Implications of the SA8000 Standard. In: Machado, C., Davim, J. (eds) Circular Economy and Engineering. Management and Industrial Engineering. Springer, Cham. https://doi.org/10.1007/978-3-030-43044-3_3

Level 3_ Integration activity :

- The Five Capitals - a framework for sustainability | Forum for the Future
- About Doughnut Economics | DEAL
- Case study: Recycled materials and the circular economy - Engineering Professors Council
- Raworth, K. (2017). *Doughnut economics: Seven ways to think like a 21st-century economist*. Chelsea Green Publishing.
- van de Poel, I., & Royakkers, L. (2023). *Ethics, technology, and engineering: An introduction* (2nd ed.). John Wiley & Sons.

C11: Ethical & Social Responsibility

Module 1

Level I Assessment - Basic

Answer all the questions that follow:

Instructions: Please select the best answer (True/False or A, B, C, D) based on the concepts presented in the Kate Raworth TED Talk.

1. ***True or False: According to the talk, the traditional goal of economic progress has been maximizing GDP growth, which is presented as always being aligned with societal thriving.***

2. ***Kate Raworth argues that the primary 21st-century goal for humanity should be:***

a) Achieving the highest possible GDP growth globally.
b) Ensuring all nations reach Rostow's "age of high-mass consumption".
c) Meeting the needs of all people within the means of the planet.
d) Focusing solely on reducing environmental impact, regardless of social needs.

3. ***True or False: The "Doughnut" model visualizes a target zone where humanity meets essential social needs (the social foundation) without exceeding Earth's critical ecological limits (the ecological ceiling).***

4. ***Which of the following is mentioned in the talk as a factor contributing to the addiction to endless economic growth?***

a) Financial systems demanding constant returns.
b) Political desire for higher tax revenue without raising taxes.
c) Social conditioning through consumer propaganda.
d) All of the above.

5. **True or False: The talk suggests that simply pursuing more economic growth is a proven strategy that will automatically fix problems like social inequality and environmental pollution.**

6. **"Regenerative design," as described in the talk, primarily involves:**

a) Creating economies that work with natural cycles, reusing resources, minimizing waste, and running on renewable energy.
b) Focusing only on regenerating specific natural landscapes, like forests.
c) Generating more financial profit from the same linear 'take-make-dispose' processes.
d) Using technology solely to replace human labour in manufacturing.

C11: Ethical & Social Responsibility

Module 1

Level I Assessment - Basic

Answer all the questions that follow:

7. ***"Distributive design" primarily aims to:***
   a) Concentrate wealth and power using traditional, centralized institutions.
   b) Distribute identical consumer goods more widely through mass consumption.
   c) Use technology and new institutional models to share value, knowledge, and empowerment more equitably.
   d) Ensure all countries follow the exact same path and timeline of economic development.

8. **True or False: The speaker uses analogies from nature to argue that while growth can be a healthy phase, attempting to grow forever is not sustainable for mature systems, including economies.**

9. **The talk presents the Doughnut's boundaries (social foundation and ecological ceiling) not just as limitations, but also as potential drivers for:**
   a) Increased government control only.
   b) A necessary return to pre-industrial lifestyles.
   c) Human and engineering creativity and innovation.
   d) Abandoning all forms of economic activity.

10. **True or False: The overall message of the talk implies that professionals like engineers have a significant role and ethical responsibility in designing solutions that help humanity meet social needs while respecting environmental limits.**

C12: Cultural & Multidisciplinary Perspective

Module 1

Learning Outcomes

Upon completing the Basic Activities, students will have the capacity to work with perspectives across different fields, including social, economic, and environmental perspectives, alongside technical perspectives.

Upon completing the Advanced Activities, students will have the capacity to independently gather and apply perspectives from fields outside of their own to develop solutions to globally-relevant problems that consider their effects on all aspects of society.

Skills

MULTIDISCIPLINARITY

CRITICAL

PROBLEM-SOLVING

SYSTEMIC

Knowledge and Understanding

SDGs

LIMITS

THREATS

GLOBAL

C12: Cultural & Multidisciplinary Perspective

Activity 1_Level Basic
Urban Challenges from Multiple Perspectives

INTRODUCTION

These activities are designed to develop students' capacities to approach engineering challenges holistically. The aim is to move beyond purely technical analysis and effectively integrate social, economic, and environmental perspectives into your problem-solving process. Students will learn to approach engineering challenges holistically by moving beyond technical analysis to consider social, economic, and environmental perspectives. They will practice identifying diverse stakeholder viewpoints, gathering relevant information from outside the engineering field, and applying this understanding to develop solutions to complex, globally-relevant problems with broad societal impact.

INSTRUCTION FOR THE STUDENTS

1. **Listen to the Scenario:** A new pedestrian and cycling bridge is proposed in your town.
2. **Join a Group & Get a Role:** In your group, each person takes on a different stakeholder role.
3. **Share Perspectives (Speed Rounds):** Take turns (1–2 mins each) sharing your stakeholder's main concerns and priorities.
4. **Class Discussion:** Reflect on what different perspectives you heard and how they might shape the final design.

DESCRIPTION (15 to 30 minutes)

1. **Introduction & Scenario (5 minutes):** Briefly introduce the importance of considering multiple perspectives in engineering projects. Present a simple engineering scenario: "A proposal has been made to build a new pedestrian and cycling bridge across a river separating a residential area from a commercial district and park in your town."
2. **Role Assignment (5 minutes):** Divide students into small groups (4-5 students). Assign each student within the group a specific stakeholder role with a brief description of their main viewpoint/concern. Example Roles:
   - **Design Engineer:** Focused on structural integrity, material costs, technical feasibility, safety regulations.
   - **Local Shop Owner:** Concerned about increased foot traffic/business, potential construction disruption, cost implications (taxes?).
   - **Environmental Scientist:** Focused on the river ecosystem, potential impact on aquatic life during/after construction, loss of green space near the banks.
   - **Community Group Leader (Residential Side):** Focused on improved access to amenities/park, potential noise increase, impact on neighbourhood character, safety for children cycling.
   - **City Planner/Economist:** Focused on overall urban connectivity, promoting active transport (health benefits), project budget, long-term economic impact.
3. **Stakeholder "Speed-Dating“ (10 minutes):** In quick rounds (1-2 minutes each), have each "stakeholder" briefly present their primary perspective, concerns, or hopes regarding the bridge project to the others in their small group. The goal is just to articulate and hear the different viewpoints quickly.
4. **Debrief (5 minutes):** Bring the class together. Ask a few groups: What were some of the conflicting perspectives you heard? How might the purely technical perspective of the engineer need to be adjusted based on the other viewpoints? Reinforce that successful engineering requires understanding and integrating these diverse, often competing, valid perspectives.

C12: Cultural & Multidisciplinary Perspective

Module 1

Activity 2_Advanced
Multi-Perspective Smartphone Sustainability

INTRODUCTION

In this activity, students will investigate the sustainability of smartphones by exploring economic, social, environmental, and technical perspectives. They will learn how to seek out non-technical information to better understand complex engineering problems.

INSTRUCTION FOR THE STUDENTS

1. **Understand the Problem:** Explore the question: How can we improve the sustainability of smartphone production and consumption?
2. **Research Perspectives:** Working alone or in pairs, find one clear example for each of the following perspectives. Use online sources and take brief notes.
   - Economic (e.g., cost, market demand, planned obsolescence)
   - Social (e.g., labour conditions, consumer behaviour, e-waste health risks)
   - Environmental (e.g., pollution, resource use, carbon footprint)
   - Technical (e.g., repairability, material choices, battery or software design)
3. **Share:** Be ready to share one example you found and where you found it (e.g., news article, report, website).
4. **Reflect:** Think about which perspectives were easier or harder to research and why. Consider why engineers need to include all of these viewpoints.

DESCRIPTION (45 to 60 minutes)

1. **Introduction & Problem (5 minutes):** Explain that engineers often need to actively seek out non-technical information to understand the full context of a problem. Present a globally relevant problem statement: "How can we improve the sustainability of smartphone production and consumption?"
2. **Guided Inquiry Task (25-35 minutes):** Working individually or in pairs, students must use online resources (start with suggested search terms or reputable sites if needed) to find and briefly summarize one concrete point for each of the following perspectives related to smartphone sustainability:
   - Economic Perspective: (e.g., cost of conflict-free minerals, market demand for new models, cost of recycling infrastructure, planned obsolescence business models)
   - Social Perspective: (e.g., labour conditions in mining/manufacturing, consumer behaviour/desire for upgrades, digital divide issues, health impacts of e-waste handling)
   - Environmental Perspective: (e.g., energy use in manufacturing/data centres, resource depletion (rare earths), e-waste pollution, carbon footprint of shipping)
   - Technical/Engineering Perspective: (e.g., designing for disassembly/repair, material science for substitution, battery life improvements, software updates vs. hardware)
3. **Quick Sharing (10 minutes):** Have a few students briefly share one finding for each perspective type (economic, social, environmental), highlighting the source or type of information they found (e.g., news article, NGO report, economic data site, scientific paper abstract). The focus is on demonstrating the ability to find relevant external perspectives.
4. **4. Reflection (5 minutes):** Briefly discuss the challenges or ease of finding information for each perspective. Emphasize the need for engineers to proactively seek out these varied viewpoints when tackling complex problems.

C12: Cultural & Multidisciplinary Perspective

Activity 3_Integrated Activity
Reducing Campus Plastic

INTRODUCTION

In this activity, students will work in teams to address a real-world sustainability challenge: reducing single-use plastic on campus. By exploring the issue through technical, social, economic, and environmental perspectives, students will learn to develop balanced, practical solutions and apply systems thinking to ethical engineering decisions.

INSTRUCTION FOR THE STUDENTS

1. **Understand the Problem:** Develop a realistic plan to reduce plastic waste from food packaging on campus.
2. **Explore & Map**: Identify key issues and stakeholders. Use a diagram to show their connections.
3. **Brainstorm Ideas**: List possible solutions (e.g., reusables, better recycling, awareness).
4. **Evaluate Options:** For your top ideas, consider: Can it work? Is it affordable? Will people use it? Will it reduce plastic?
5. **Make a Plan:** Choose your best idea(s) and explain how they balance technical, social, economic, and environmental factors.
6. **Present & Discuss:** Share your plan and how you balanced perspectives. Join the class discussion.

DESCRIPTION (70-90 minutes)

1. **Problem Introduction (10 minutes):** Present a complex, multi-faceted engineering challenge: "Develop a plan to significantly reduce single-use plastic waste originating from food packaging and consumption within the university campus environment." Explain that the goal isn't a perfect final design, but a well-justified proposal that explicitly balances different perspectives.
2. **Group Work - PBL Cycle (40-60 minutes):** Divide students into groups. Guide them through a simplified PBL process:
   - **Define & Analyse Problem:** What are the technical aspects? Who are the key stakeholders (students, food vendors, university admin, waste management, suppliers)? What are their likely perspectives (building on Core activity skills)? Use mapping/systems thinking to visualize connections.
   - **Brainstorm Solutions:** Generate a range of potential interventions (e.g., reusable container schemes, water refill stations, vendor incentives/penalties, biodegradable packaging mandates, awareness campaigns, improved recycling infrastructure).
   - **Gather & Integrate Perspectives (Simulated/Guided):** For their top 1-2 solutions, groups must consider/find information on:
     - **Technical Feasibility**: Can it be implemented reliably?
     - **Economic Viability:** What are the costs/savings for vendors, students, university?
     - **Social Acceptability/Usability:** Will students/vendors participate? Is it convenient? Are there equity concerns?
     - **Environmental Impact:** Does it genuinely reduce plastic? Are there unintended consequences (e.g., water/energy use for washing reusables)?
     - (You can provide brief perspective snippets or guide quick searches here, building on Advanced activity skills, if you completed this activity)
   - **Develop Proposed Plan:** Select and outline a multi-pronged plan, explaining how it attempts to balance the technical requirements with the gathered economic, social, and environmental perspectives and trade-offs.

Activity 3_Integrated Activity Reducing Campus Plastic

DESCRIPTION (PAGE 2)

3. **Presentations & Discussion (15-20 minutes):** Each group briefly presents their proposed plan, specifically highlighting how they considered and balanced different perspectives. Facilitate a class discussion comparing approaches and the challenges of integrating diverse viewpoints.

4. **Wrap-up (5 minutes):** Summarize the importance of this interdisciplinary approach for developing robust and responsible engineering solutions to real-world problems.

C12: Cultural & Multidisciplinary Perspective

Module 1

Applied teaching pedagogies:

Pedagogies for Level 1 _Basic activity

OP1 Role-Play

OP2 Simulation

Pedagogies for Level 2_ Advanced activity

16P Web Quests

02P Guided Inquiry

Pedagogies Level 3_ Integration activity

03P Problem-Based Learning

14P Systems Thinking Exercise

C12: Cultural & Multidisciplinary Perspective

Module 1

Direct References:

Level 1 _Basic activity:

- Murray, J. K., Studer, J. A., Daly, S. R., McKilligan, S., & Seifert, C. M. (2019). Design by taking perspectives: How engineers explore problems. *Journal of Engineering Education, 108*(3), 417–442. https://doi.org/10.1002/jee.20263

Level 2_ Advanced activity:

- Saruchera, F. Sustainability: A Concept in Flux? The Role of Multidisciplinary Insights in Shaping Sustainable Futures. Sustainability 2025, 17, 326. https://doi.org/10.3390/su17010326 - https://www.mdpi.com/2071-1050/17/1/326

Level 3_ Integration activity:

- Saruchera, F. Sustainability: A Concept in Flux? The Role of Multidisciplinary Insights in Shaping Sustainable Futures. Sustainability 2025, 17, 326. https://doi.org/10.3390/su17010326 - https://www.mdpi.com/2071-1050/17/1/326
- Murray, J. K., Studer, J. A., Daly, S. R., McKilligan, S., & Seifert, C. M. (2019). Design by taking perspectives: How engineers explore problems. *Journal of Engineering Education, 108*(3), 417–442. https://doi.org/10.1002/jee.20263

C12: Cultural & Multidisciplinary Perspective

Module 1

Level I Assessment - Basic

Answer all the questions that follow:

1. **True or False: The "Stakeholder Speed-Dating" activity primarily showed that engineering projects, like the proposed bridge, only have significant technical and financial consequences.**

2. **In the bridge scenario activity, the "Local Shop Owner" character primarily represented which type of perspective?**
   a) Environmental
   b) Technical
   c) Social
   d) Economic

3. **The role of the "Environmental Scientist" in the activity was mainly concerned with:**
   a) The overall cost of bridge construction and materials.
   b) The potential impact on the river's ecosystem and nearby habitats.
   c) The detailed structural integrity and safety calculations for the bridge.
   d) Ensuring the bridge increased foot traffic for local businesses.

4. **True or False: The activity suggested that the perspective of the "Design Engineer," focused on technical feasibility and cost, is generally sufficient on its own to determine if the bridge project is a good idea overall.**

5. **The different stakeholder roles assigned in the bridge scenario activity (e.g., Engineer, Shop Owner, Scientist, Resident, Planner) generally demonstrated that stakeholders:**
   a) All shared the exact same goals and priorities for the project.
   b) Represented diverse, and sometimes conflicting, interests and concerns regarding the project.
   c) Were only capable of seeing the negative aspects of building the bridge.
   d) Focused primarily on global political issues rather than local impacts.

6. **True or False: Considering social perspectives, such as those represented by the "Community Group Leader" (e.g., effects on connectivity, noise, neighbourhood character), is relevant to engineering projects because these projects directly impact people's lives and communities.**

Level I Assessment - Basic

Answer all the questions that follow:

7. **The core learning outcome, "working with perspectives across different fields," implies that engineers should aim to:**
   a) Prioritize the technical solution above all other considerations.
   b) Persuade all stakeholders that the purely technical viewpoint is correct.
   c) Be aware of, understand, and integrate relevant social, economic, and environmental factors alongside technical aspects in their work.
   d) Focus only on minimizing the project's financial cost.

8. **True or False: Based on the interactions simulated in the activity, it is realistic to expect that all stakeholders involved in a real engineering project will easily agree on the best path forward.**

9. **Why is understanding perspectives like those of the "City Planner/Economist" important for an engineering team working on the bridge project?**
   a) Because economic factors are the only factors that determine if a project is built.
   b) To grasp the project's budget realities, funding sources, and its fit within broader urban development goals and economic strategies.
   c) Because city planners typically handle all the technical design work themselves.
   d) It helps engineers learn about local politics but doesn't influence the design.

10. **True or False: The bridge scenario activity illustrated that even a relatively small-scale engineering project involves a complex web of interconnected technical, social, economic, and environmental issues.**

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Co-funded by
the European Union