Learning Objectives

Materials

Foundational Knowledge

Key information:

- 1.1 | A material's engineering performance encompasses the entire material life cycle.
- 1.2 Natural and artificial materials have fundamentally different life cycle behaviors.
- **1.3** | Material resources are finite in our closed thermodynamic system of earth.

Key ideas or concepts:

- 1.4 | Realize that all sustainable materials accounting systems are based on current understanding; each has inherent limitations.
- **1.5** | Realize that our scientific models are in a process of becoming more accurate; all models are "wrong," yet some are useful.
- **1.6** Understand that not all interventions are equal; interventions that change the design assumptions have a higher potential to change systemic outcomes.
- 1.7 | Understand that enlarging the boundaries of the system create more and higher impact opportunities for systemic re-design.
- 1.8 | Realize that there are several frameworks for developing strategies for sustainable designs; examples include: The IPAT equation; Daly sustainability principles, Green Chemistry and Engineering Principles; Biomimicry; Meadow's Hierarchy of Systemic Interventions.

Application

Critical thinking:

- **2.1** | From data on a material's life cycle behavior, identify potential high-leveraged intervention opportunities.
- **2.2** | Evaluate and articulate potential social and environmental consequences associated with a material.
- 2.3 | Assess the potential appropriateness of specifying specific materials in different geographical settings by evaluating the materials life cycle behavior.

Creative thinking:

- 2.4 | Imagine the viable applications of "waste" materials from a material's life cycle.
- 2.5 | Conceive of ways that biomimicry principles can be applied in a specific material case.
- 2.6 | Conceive of ways that green engineering principles can be applied in a specific material case.

Practical thinking:

2.7 | Use Meadow's hierarchy of systems interventions to identify high-leveraged opportunities to lower the impact of a design.

Skills:

2.8 | State the general framework of a material life cycle.

Integration

- **3.1** | Realize that using materials in products implies the entire life cycle activities that includes resource use and waste outputs at each stage.
- **3.2** | Formulate questions about the local, regional and global implications of each step in a material's life cycle; (i.e. civil war, conflict, loss of biodiversity, etc.)
- **3.3** | Realize that material use can have societal implications ranging from new economies to civil war, conflict, social inequity, depending on the design choices in the life cycle.
- **3.4** | Realize that materials use can have environmental implications ranging from ecosystem recovery to biodiversity loss and pollution, depending on the design choices in the life cycle.

Human Dimension

- **4.1** Understand that the personal and professional decisions we make regarding the materials we use have a profound impact on ourselves and the environment.
- **4.2** | Be able to articulate their interpretation of the meaning of the engineer's creed with respect to the implications of their personal and professional choices.

Caring

- 5.1 | Develop an interest in using one's engineering understanding to create sustainable alternatives to industrial-era products and processes.
- **5.2** | Feel empowered by understanding to innovate sustainable alternatives to industrial-era products and processes.

Learning How to Learn

- **6.1** Formulate questions about broader societal implications of materials in designs.
- **6.2** | Practice the virtues of critical thinking when evaluating new information:
 - Intellectual integrity, 2. Intellectual humility, 3. Confidence in Reason, 4. Intellectual Perseverance, 5. Fairmindedness, 6. Intellectual Courage, 7. Intellectual Empathy,
 - 8. Intellectual Autonomy

What impact do I want this module experience to have on students, which will still be there a year or more after the course is over?



Learning Objectives

Fink Taxonomy of Significant Learning

Integration (3)

What connections (similarities and interactions) should students recognize and make...

- Among ideas within this course?

life?

- Between the information, ideas, and perspectives in this course and those in other courses or areas?

- Between material in this

course and the students' own

personal, social, and work

Application (2)

What kinds of thinking are important for students to learn here:

Critical thinking, in which students analyze and evaluate?
Creative thinking, in which students imagine and create?
Practical thinking, in which students solve problems and
make decisions?

What important skills do students need to learn?

What complex projects do students need to learn how to manage?

Human Dimension (4)

What can or should students learn about themselves?

What can or should students learn about understanding and interacting with others?

Foundational Knowlege (1)

What key information (facts, terms, formula, concepts, relations...) is important for students to understand and remember in the future?

What key ideas or perspectives are important for students to understand in this module?

Caring (5)

What changes would you like to see, in what students care about, that is, any changes in their...

- Feelings?
 - Interests?
 - Values?

(6)

Learning

How to Learn

What would you like for students to learn about...

- How to be a good student in a course like this?
- How to engage in inquiry and construct knowledge with this subject matter?
- How to become a self-directing learner relative to this subject? That is, having a learning agenda of what else they need and want to learn and a plan for learning it.

What impact do I want this module experience to have on students, that will still be there a year or more after the course is over?