**ROMBLON STATE UNIVERSITY**

**College of Engineering and Technology**

**Main Campus, Odiongan, Province of Romblon**

**HANDOUT #4**

**CE4113 ENVIRONMENTAL ENGINEERING MW: 10-11:30; TTH: 10-11:30AM**

**Engr. Reynaldo P Ramos, PhD MF: 4-5:30; TTH: 4-5:30PM**

1. **SUSTAINABILITY AND CRADLE-TO-CRADLE DESIGN**

**Sustainable Materials Management (SMM)** – an approach to promote sustainable materials use, integrating actions targeted at reducing negative environmental impacts and preserving natural capital throughout the life-cycle of materials, taking into account economic efficiency and social equity.

**Framework for Sustainability**

It is also called as “The Natural Step” – a framework that provides a set of four system conditions that define a sustainable society based on the laws of thermodynamics and natural cycle. This also considers that the Earth as a closed system for materials and as an open system for energy that sustains life through a complex interactive network of material cycles that uses solar energy to counteract the tendency of materials to dissipate and otherwise increase in entropy.

1. *Extracting concentration of substances from the Earth’s crust* – condition that refers to the extraction of minerals and fossil fuels which these substances are scarce and should be substituted with those that are more abundant. It should be used efficiently and recycled, and dependence on fossil fuels should be systematically reduced.
2. *Building up concentrations of human-made compounds in nature* – condition that refers to the manufacture of persistent and unnatural compound which should be replaced with those that are abundant and or that break down completely and easily in nature. All substances produced should be used efficiently.
3. *Utilizing renewable resources at rates faster than they are regenerated and reducing the productive capacity of nature* – condition refers to the use of natural resources which should be drawn only from well managed ecosystems for productive and sustainable uses.
4. *People are able to meet their needs worldwide* – condition means using all the resources efficiently, effectively, fairly, and responsibly for the use of future generation.

**Cradle-to-cradle Design**

It is the same concept to the design of human industry. The key principle is just as in natural systems where one organism’s waste becomes food for another. It is also defines two metabolisms within which materials are conceived as nutrients circulating benignly and productively through metabolisms: biological nutrients within biological metabolism, and technical nutrients cycle within technical metabolisms.

Three design principles are:

1. Use of current solar income – harnessing solar energy directly and indirectly for human purposes
2. Celebrate diversity – development of diverse products fitting for different preferences, cultures, ecosystems, and geographies.
3. Waste equals food – no waste in nature; human system can be designed to circulate materials productively to eliminate generation of waste.
4. **ENGINEERING DECISIONS**

*“Environmental engineers have the immense responsibility of protecting both humans and the environment. Our decisions directly and indirectly affect lives and ecosystems, so we must take into consideration a multitude of factors when making decisions.”*

The implementation of any engineering project – large or small entails series of decisions made by engineers. The potential to harm thousands at a time through incorrectly designed systems by engineers is inevitable.

1. Decisions based on technical analyses – design, specifications, technical data/information
2. Decisions based on cost-effectiveness analyses – annual cost, present worth, capital cost, interest, capital recovery factor
3. Decisions based on benefit/cost analyses – Ratio between benefit and cost is more than 1.0, monetary values
4. Decisions based on risk analyses – life and health, hazards, mortality (deaths)
5. Decisions based on alternatives assessment – green chemistry and green engineering; benchmarking
6. Decisions based on environmental impact analyses – identify potential impacts to the environment (importance, magnitude, and nature (either positive or negative effect)
7. Decisions based on ethical analyses – environmental ethics, values and spirituality

**CASE STUDY:**

**The local government units of Sibuyan and Tablas Islands have received financial assistance from the World Bank to improve the waste collection and disposal system of these two islands in Romblon. It was proposed to purchase new units of dump trucks to meet the current demand of the islands. However, the purchase or acquisition of the new trucks will be done per island. Due to accessibility and road network problem, the truck can only collect the solid waste from the 40% of the population. Determine or compute the following:**

1. Total solid waste generation per municipality (kg per day)

2. Number of trucks (25 cubic meters capacity per truck) needed per island.

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| **Municipality** | **Population (2016)** | **Assumption** |
| Sibuyan Island |  | 1. Solid waste generation rate of 1.5kg/capita/day. 2. Refuse compaction rate of the dump truck is 400 kg/cubic meters 3. One dump truck 25 cubic meters capacity. Can collect twice a day. |
| San Fernando | 23,271 |
| Cajidiocan | 21,861 |
| Magdiwang | 14,142 |
| Tablas Island |  |
| San Andres | 15,589 |
| Odiongan | 45,367 |
| Ferrol | 6,964 |

**Reference:**

Vesilind P.A, Morgan, S.M., and Heine, L.G. (2013*). Introduction to Environmental Engineering*, 1st Philippine reprint, Singapore: Cengage Learning Asia Pte Ltd.