



ME290

**Global Engineering Professional
Seminar**

Impact of Engineering Solutions

Lecture-1

Impact of Engineering Solutions

ABET* requirement: General Criterion 3. Student Outcomes

The program must have documented student outcomes that prepare graduates to attain the program educational objectives:

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, **social, environmental, and economic** factors
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, **economic, environmental, and societal** contexts

*ABET (Accreditation Board for Engineering and Technology, Inc.) is an organization that accredits post-secondary education programs.

Impact of Engineering Solutions

Typical Design Considerations

- Performance
- Weight
- Cost
- Reliability
- Manufacturability
- Assemblability
- Testability
- Maintainability
- Life/Durability
- Safety
- Functionality and Usability
- Style, Shape and Size
- Laws and Regulations

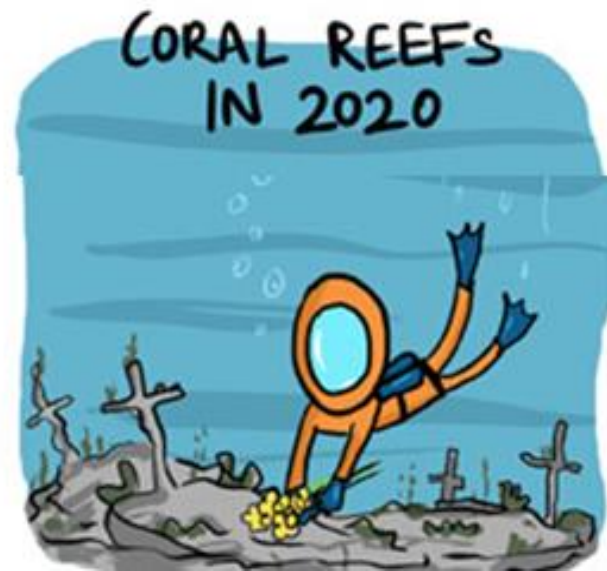
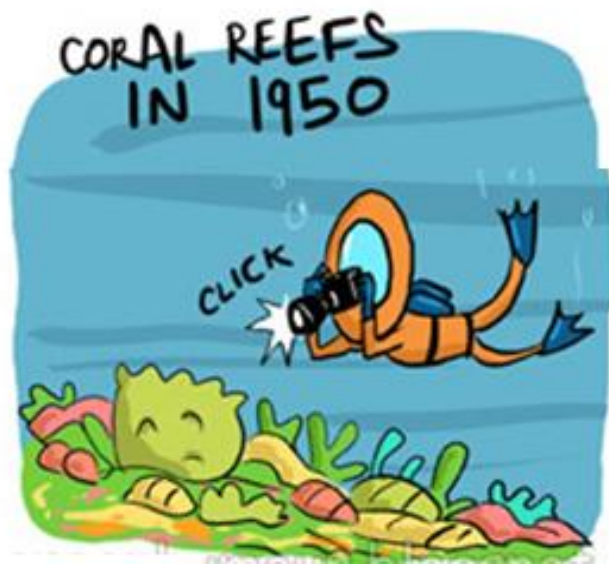


What
About?

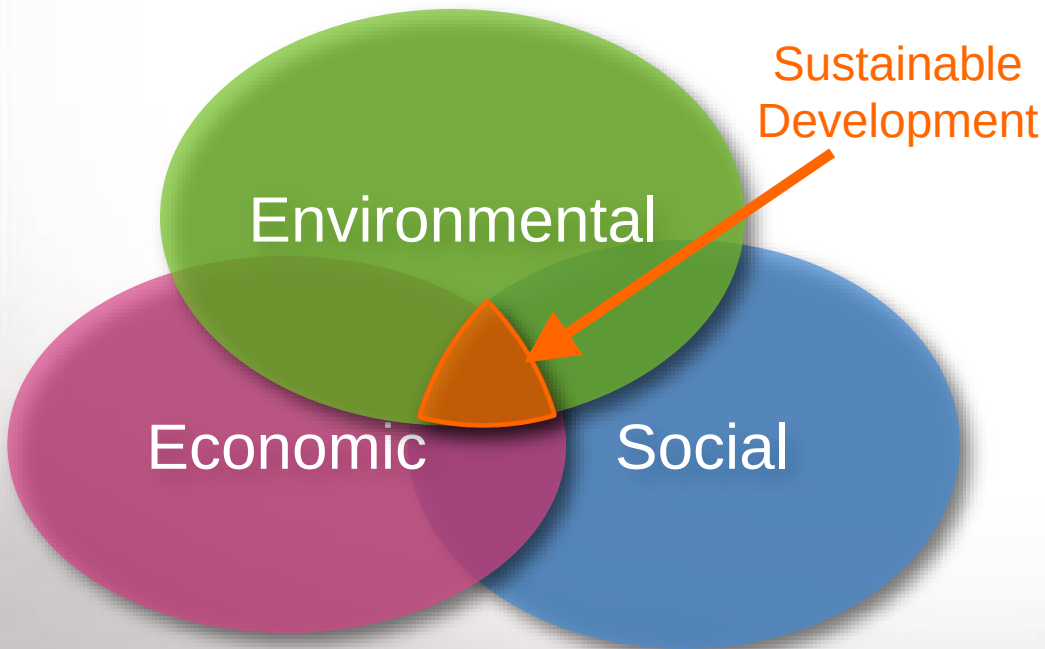
Environment?
and Society?

Engineers Are Action Oriented and Action Means Change

- Engineering solutions/actions may Produce **Unexpected** and **Unwanted** Results
- Actions may have unforeseen or neglected **Environmental** and **Social** Consequences



Engineering Sustainable Development aims to balance the three elements:



- **Economic:** what things cost - and how to make a business out of providing infrastructure, goods or services
- **Environmental:** what impact those things have on nature and the earth's support systems
- **Social:** how those things serve the needs and quality of life of people and their communities

Example

Three Gorges Dam

- The largest dam in the world. Over a mile and a half long and 600 feet high.
- Has displaced over 1.5 million people.
- Located on the Yangtze River in the Three Gorges Region.



Example



Problems:

- Displacement of people and losing their properties
- Flooded villages, agricultural fields, historical and archeological sites
- Pollution increase in still water
- Local climate change and effect on local habitat (animals, plants, fish, etc.)
- Risk of Dam failure
- Landslides/earthquakes

Benefits:

- Electricity Production with no gas emissions
- Flood Control
- Water reservoir for agricultural fields
- Fishery in the reservoir
- Easy transportation over the river

Example

Problem: Need for energy

Solution: Nuclear power

Unintended Consequence:

Nuclear waste, concerns over nuclear weapons capability etc.



"Risky? Good lord, no! We're going to make a fortune!"

Example

Problem:

- Manual Labor
- Low Productivity
- Slow Transportation

Solution: Industrialization

Unintended Consequence:

- Air Pollution
- Poor working conditions
- Urban Problems



Example

Problem:

Low Productivity

Solution: Automation

Unintended Consequence:

Unemployment



Example

Problem:

Need for instantaneous, global communication

Solution: The Internet

Unintended Consequence:

Social isolation in some cases, socially unacceptable uses etc.



Example

Problem:

Soil Erosion

Solution: Introduce Kudzu Plant
from Japan

Unintended Consequence:

Overrun with Vines

Killing of Other Vegetation

Power Lines Shorting Out

Etc.



Southeastern USA Kudzu

Example

Use of Chemicals

Following are some examples of products or processes that created unforeseen environmental problems after their introduction:

- Insect killers, such as DDT, endrin, dieldrin, and benzene hexachloride (BHC).
- Alkylbenzene sulfonate (ABS) synthetic detergents.
- Polychlorinated biphenyls (PCBs).
- Chlorofluorocarbons (CFCs).
- Lead used in gasoline and paint.
- Some chlorinated solvents.
- Wood preservatives.



- Over the last 50 years, engineering **projects** and **products** - has benefited large numbers of people, *but:*
- The way we have been doing our development is often “unsustainable” - in social and environmental terms
- This leads to real fears about the security and quality of life that our children and grandchildren - can expect

“We do not inherit the earth from our ancestors - we borrow it from our children”

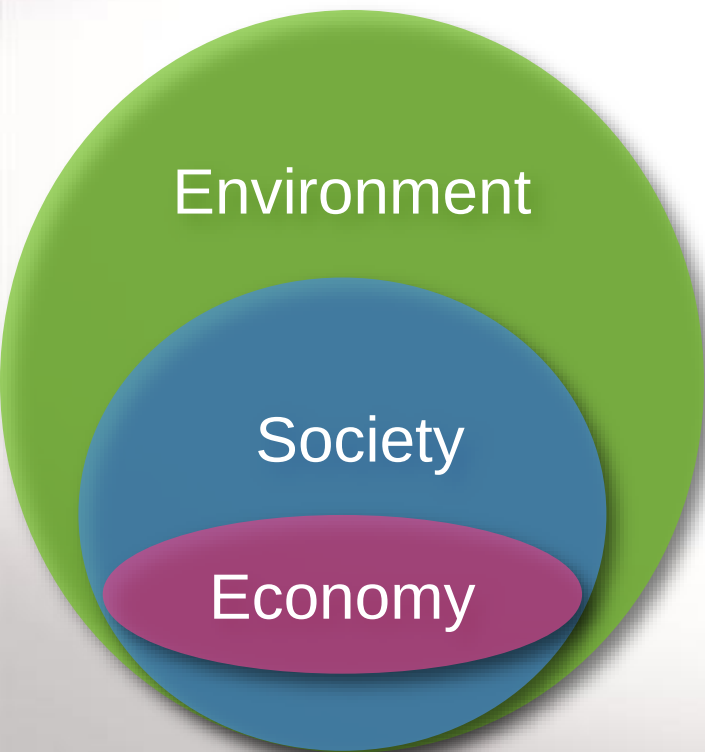
(Anon – Native American Indian)



Group Exercise

- Provide three (3) real-world examples of proposed engineering solutions which have had a significant impact on society and environment.
- Briefly discuss the original problem which inspired each proposed solution and the positive and negative impacts of each of the solutions

Examples to Live More Sustainably



Environmental sustainability doesn't mean living without luxuries but rather being aware of your resource consumption and reducing unnecessary waste.

- Reduce household energy use
- Reduce fuel consumption
- Reduce plastic usage
- Plant seeds.
- Recycle.
- Eat locally.
- Resell and donate items.
- Save water.
- ...



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Sustainable Development

The Hannover Principles of Sustainable Development

1. Insist on rights of humanity and nature to co-exist

in a healthy, supportive, diverse and sustainable condition.

2. Recognize interdependence.

The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.

3. Respect relationships between spirit and matter.

Consider all aspects of human settlement including community, dwelling, industry and trade in terms of existing and evolving connections between spiritual and material consciousness.

4. Accept responsibility for the consequences of design decisions

upon human well-being, the viability of natural systems, and their right to co-exist.

5. Create safe objects of long-term value.

Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creation of products, processes or standards.

6. Eliminate the concept of waste.

Evaluate and optimize the full life-cycle of products and processes, to approach the state of natural systems, in which there is no waste.

7. Rely on natural energy flows.

Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate the energy efficiently and safely for responsible use.

8. Understand the limitations of design.

No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not an inconvenience to be evaded or controlled.

9. Seek constant improvement by the sharing of knowledge.

Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity.

What should engineers be doing to avoid negative impact of engineering solutions?

- Be careful and knowledgeable in Choosing Technology
- Understand the environment
- Estimate social impacts
- Assess the positive and negative implications of particular technological solutions
- Obtain societal/legal approvals before implementing a solution



A huge new technical challenge: - energy and materials efficiency

- We can drive materials efficiency:
 - “600 tonnes of material are used to make 60 tonnes of product of which 6 tonnes are in use 6 months later”
 - (Lord Sainsbury, Minister for Science and Industry)
- We can drive energy efficiency:
 - “The whole economy is less than 10% as energy-efficient as the laws of physics permit”
 - (From “Natural Capitalism” 1999)

Question:

- Are we educating our engineering graduates to deal with the key issue of the 21st Century?*

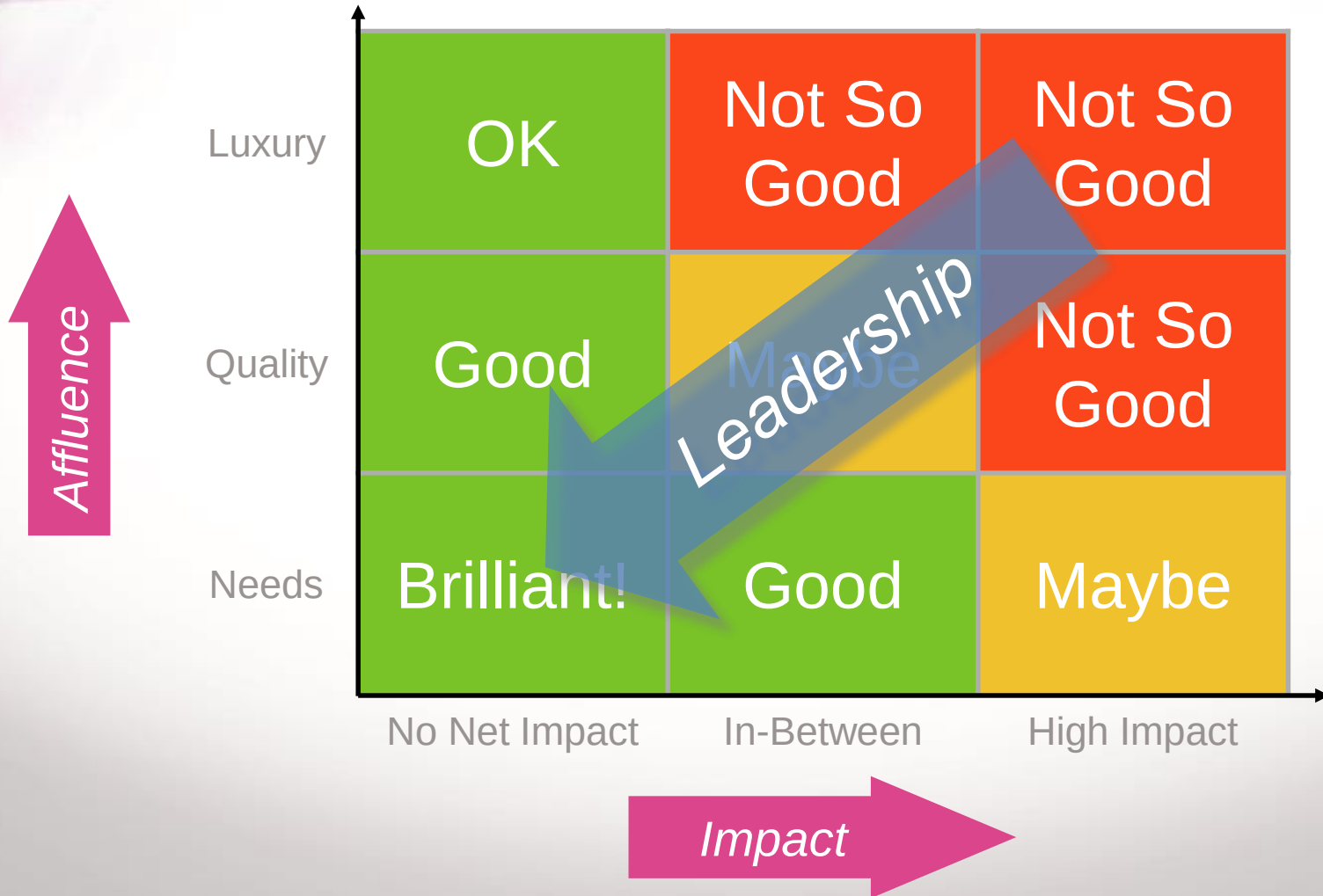




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Choosing Solutions



*Engineers need to learn to
engage better with communities,
to implement the complex
solutions that sustainability needs*

End of “Impact of Engineering Solutions” **Lecture-1**