Module – 3
Engineering as Social Experimentation

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ENGINEERING AS EXPERIMENTATION

- **The process of engineering lets you go through a series of different experiments when it comes to practical use.**
- **Experimentation plays an important role in the process of designing the product.**
- **Though it is not like an experiment in laboratory under controlled conditions, which is done while learning, an engineer should be ready to do the same on a social scale involving human subjects.**

Engineering Projects v/s Standard Experiments

Similarities	*Contrasts*
Uncertainty (E.g. leakage of nuclear radiation)	**Experimental control**
Continuous monitoring	**Humane touch (Medicine)**
Learning from the past	**Informed consent**
Partial ignorance	**Close Observation**

ENGINEERS AS RESPONSIBLE EXPERIMENTERS

- **In the process of developing a product, an engineer generally learns through experimentation.**

Responsibility of Engineers in Experimentation

1. **Conscientiousness (Sense of awareness)**
2. **Informed Consent (One should be informed of the facts)**
3. **Moral Autonomy**
4. **Accountability (Moral responsibility)**

CODES OF ETHICS

The 'codes of ethics' exhibit, rights, duties, and obligations of the members of a profession and a professional society.

The codes exhibit the following essential roles:

1. ***Inspiration and guidance***
2. ***Support to engineers***
3. **Serving and protecting the public**
4. **Education and Mutual understanding**
5. **Shared Standards**
6. ***Create good public image***
7. ***Deterrence (discourage to act immorally)*** **and discipline (regulate to act morally).**
8. ***Promotes business interests***

Advantages of Codes of Ethics

- Set out the ideals and responsibilities of the profession.
- Improve the profile of the profession.
- Motivate and inspire practitioners
- Provide guidance.
- Raise awareness and consciousness of issues.
- Improve quality and consistency.

Limitations

- General and vague wordings
- Not applicable to all situations
- Often have internal conflicts

PLAGIARISM

- **Princeton perceives plagiarism as the "deliberate" use of "someone else's language, ideas, or other original (not common-knowledge) material without acknowledging its source."**
- **Oxford characterizes plagiarism as the use of "a writer's ideas or phraseology without giving due credit."**
- **Plagiarism can occur in many forms (writing, art, music, computer code, mathematics etc.,)**
- **What we call originality is actually the innovative combining, amending, or extending of material from that pool.**

A BALANCED OUTLOOK ON LAW

- **The ‘balanced outlook on law’ in engineering practice stresses the necessity of laws and regulations and also their limitations in directing and controlling the engineering practice.**
- **Laws are needed to provide a minimum level of compliance.**

The following codes are typical examples of how they were enforced in the past:

<u>Babylon's Building Code (1758 BC)</u>

- **This code was set by Hammurabi, king of Babylon.**
- **"If a builder has built a house for a man and has not made his work sound, and the house which he has built was fallen down and so caused the death of the householder, that builder shall be put to death. If it causes the death of the house holder's son, they shall put that builder's son to death. If it causes the death of the house holder's slave, he shall give slave to the householder…."**

The United States Steamboat Code (1852 AD)

- **Alfred Guthrie, an engineer of Illinois had inspected around 200 steam boats with his own funding and found out the reasons for the boiler explosions and later prepared a report relating to the care that could be taken later.**
- **The recommendations made by Alfred Guthrie, an engineer of Illinois were published by Senator Shields of Illinois and incorporated in senate documents which later was made a law, which made the ASME, to formulate the standards in the manufacturing of steam boats.**

The Challenger Case study

- **Explosion of the space shuttle 'Challenger'**
- **This case had been reviewed vigorously by media coverage, government reports and transcripts of hearings. This case deals with many ethical issues which engineers faced.**
- **It poses many questions before us. A few questions are listed below –**
    - **What is the exact role of the engineer when safety issues are concerned?**
    - **Who should have the ultimate authority for decision making to order for a launch?**
    - **Whether the ordering of a launch be an engineering or a managerial decision?**

- **The accident took place on 28th January 1986, due to the failure of one of the solid boosters. In the design of the space shuttle, the main parts which needed careful design of the fields joints where the individual cylinders were placed together.**
- **Challenger space shuttle mainly consisted of an orbiter, two solid propellant boosters and a single liquid-propeller booster, which was actually designed to be a reusable one. All the boosters were ignited and the orbiter took a lift-off from the earth. But the cold temperature caused trouble to the O-rings which were eroded.**

- **Delayed in launch due to many factors**
- **President Regan appointed a commission called the Rogers Commission which constituted of many distinguished scientists and engineers.**
- **The investigation results shows how lack of responsibility and morality, improper functions, and lax performance of duties of the engineers resulted in the crash.**

The Challenger Case study : Inferences

- **Moral/Normative Issues**
  - **The crew had no escape mechanism. A 'safe exit' was rejected as too expensive**
  - **The crew were not informed of the problems existing in the field joints.**
  - **Engineers gave warning signals on safety. But the management group prevailed over and ignored the warning.**
- **Conceptual Issues**
  - **NASA counted that the probability of failure of the craft was one in one lakh launches.**
  - **There were 700 criticality items, which included the field joints. A failure in any one of them would have caused the tragedy. No back-up or stand-bye had been provided for these criticality components.**
- **Factual/Descriptive Issues**
  - **Field joints gave way in earlier flights. But the authorities felt the risk is not high.**
  - **NASA has disregarded warnings about the bad weather, at the time of launch, because they wanted to complete the project, prove their supremacy, get the funding from Government continued and get an applaud from the President of USA.**

BHOPAL GAS TRAGEDY

- **Bhopal's Gas tragedy is the world's worst industrial disaster that occurred in 1984, due to the gas leakage from a pesticide production plant, The Union Carbide India Limited (UCIL) located in Bhopal, Madhya Pradesh.**
- **It was believed that slack management and deferred maintenance together created a situation where routine pipe maintenance caused a backflow of water into the MIC tank, triggering the disaster.**

- **It was understood that a large volume of water had been released into the MIC tank and this further caused a chemical reaction that forced the pressure release valve to open and allowed the gas to leak**
- **As per government's announcement, a total of 3,787 deaths occurred immediately. Around 8,000 of the survivors died within two weeks and other 8,000 or more died from acute diseases caused due to the gas later.**