Engineering Ethics
(Hum 4441)

Lecture 10

ENGINEERING AS SOCIAL EXPERIMENTATION

- To undertake a great work and especially a work of novel type means, carrying out an experiment.
- **Experimentation:**
  - A test under controlled conditions that is made to demonstrate a known truth, to examine the validity of a hypothesis, or to determine the efficacy of something previously untried. The process of conducting such a test is called as a experimentation.

What is a Engineering?

- Engineering is the application of science and math concerned with the design, building, and use of engines, machines, and structures.
- Engineers figure out how things work and find practical uses for scientific discoveries.
- **To solve real world problems that improve the world around us.**

Engineering & Experimentation

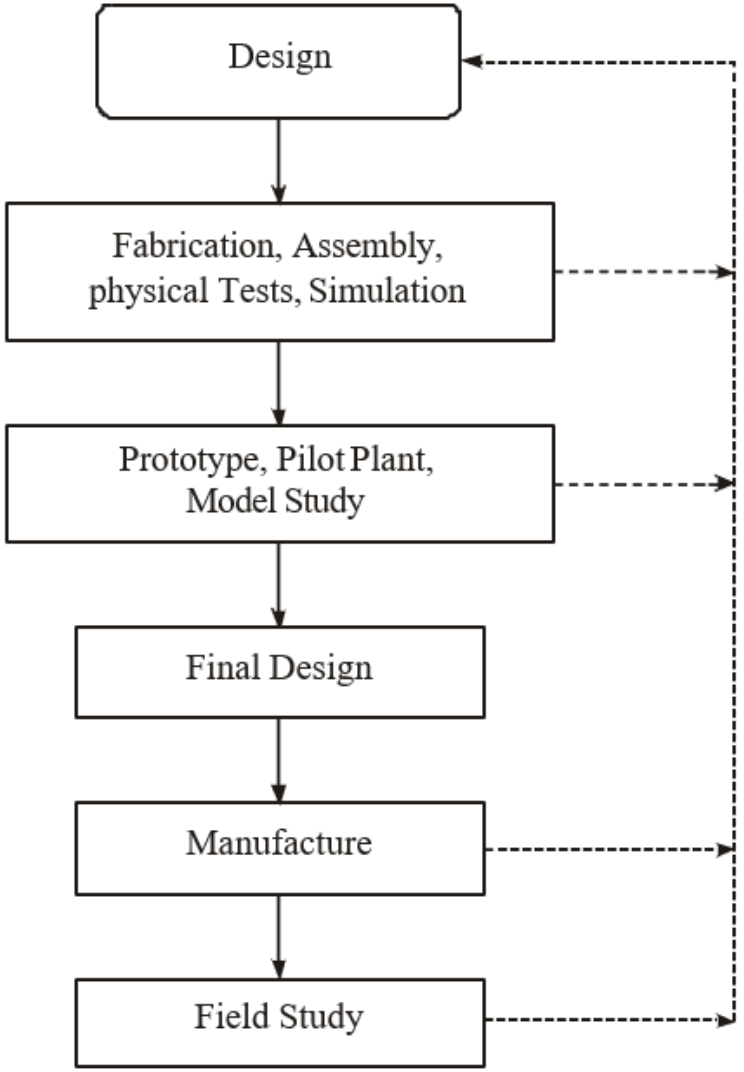
- Experimentation (Preliminary tests or Simulations) plays a vital role in the design of a product or process(Engineering).
- Engineering is inherently a risk activity.
- So Engineering should be viewed as a experimental process.
- Engineering involves people, environment, nature.

ENGINEERING AS EXPERIMENTATION

- Experimentation (Preliminary tests or Simulations) plays a important role in the design of a product or process.
- Experimentation refers the activity, process or practice of making experiments
- In all stages of converting a new engineering concept into a design like,
  - First rough cut design,
  - Usage of different types of materials and processes,
  - Detailed design,
  - Further stages of work design
  - Before manufacturing a product or providing a project, we make several assumptions and trials
  - The test for designing should be evolved till the final product produced. With the help of feedback of several tests, further modification can be made if necessary.
  - The finished product,
- Experiments and tests are conducted to evaluate the product. Modifications are made based on the outcome of these experiments.

ENGINEERING AS EXPERIMENTATION

- Several redesigns are made upon the feedback information on the performance or failure in the field or in the factory. Besides the tests, each engineering project is modified during execution, based on the periodical feedback on the progress and the lessons from other sources. Hence, the development of a product or a project as a whole may be considered as an experiment.



Benefits of Experimentation

- Coming up with the best version of the product by trying various iterations.
- Utilizing experiments as a means to seek feedback and carrying out further improvements
- Technically, it may seem a perfect product but it might vary when executed behaviorally. Experiments help find out behavioral usage flaws For eg. The design of a water bottle may seem perfect with respect to its engineering specifications but might be a pain when holder for long by the person using it.

Engineering Projects VS. Standard Experiments (*Similarities*)

- ***Partial ignorance:*** Any project is carried out in partial ignorance due to
  - The uncertainties in the abstract model used for the design calculations.
  - The uncertainties in the precise characteristics of the materials purchased. They may vary with the suppliers, processed lot, time, and the process used in shaping the materials (e.g., sheet or plate, rod or wire, forged or cast or welded).
  - The uncertainties caused by variations in processing and fabrication of materials and
  - The uncertainties about the nature of stresses the finished product will encounter. It is not possible to collect data on all variations.

Engineering Projects VS. Standard Experiments (*Similarities*)

- ***Uncertainty***: The final outcomes of projects are also uncertain, as in experiments and even small and mild projects itself involve greater risks.

- Some times unintended results, side effects (bye-products), and unsafe operation have also occurred.

- Unexpected risks, such as undue seepage in a storage dam, leakage of nuclear radiation from an atomic power plant, presence of pesticides in food or soft drink bottle, an new irrigation canal spreading water-borne diseases, and an unsuspecting hair dryer causing lung cancer on the user from the asbestos gasket used in the product have been reported.

Engineering Projects VS. Standard Experiments (*Similarities*)

❑ *Continuous monitoring*:

- **Monitoring is an essential part of experimentation.**
- This monitoring is done by **making periodic observations and tests** by looking at for the successful performance and the side effects of the jobs.
- Monitoring continually the progress and gaining new knowledge are needed before, during, and after execution of project as in the case of experimentation.
- The performance is to be monitored even during the use (or wrong use!) of the product by the end user/beneficiary.
- The tests of the product's efficiency, safety, cost-effectiveness, environmental impact and its value that depends upon the utility to the society should also be monitored.

Engineering Projects VS. Standard Experiments (*Similarities*)

❑ *Learning from the past*:

- Engineers normally learn from their own prior designs and infer from the analysis of operation and results, and sometimes from the reports of other engineers.
- Engineers should learn not only from their own earlier design and operating results, but also from **other engineers**.
- Engineers repeat the past mistakes of others due to the following reasons.
  - Lack of established channels of communication.
  - Misplaced pride in not asking for information
  - Embarrassment at failure or fear of Law's (legal problems).
  - Negligence.

Engineering Projects VS. Standard Experiments (*Similarities*)

- *Learning from the past*:
- The tragedy of 'Titanic' happened on April 15,1912.Because of the **insufficient number of life boats** resulting in the death of 1522 out of 2227 (life boat capacity available was only 825), The same disaster took place in the steamship "the Arctic" some years before, because of the same problem.

Engineering Projects VS. Standard Experiments (*Contrasts*)

1. Experimental control: In standard experiments, members for study are selected into two groups namely A and B at random.

- The members of the group 'A' should be given the special experimental treatment.
- The group 'B' do not receive the same though they are in the same environment. This group is called the 'control group'. This process is called the *experimental control*. This practice is adopted in the field of medicine.
- In engineering, this does not happen, except when the project is confined to laboratory experiments. This is because it is the clients or consumers who choose the product, exercise the control. It is not possible to make a random selection of participants from various groups. In engineering, through random sampling, the survey is made from among the users, to assess the results on the product.

Engineering Projects VS. Standard Experiments (*Contrasts*)

***2. Humane touch*:** Engineering experiments involve human souls, their needs, views, expectations, and creative use as in case of social experimentation. This point of view is not agreed by many of the engineers. But now the quality engineers and managers have fully realized this humane aspect.

Engineering Projects VS. Standard Experiments (*Contrasts*)

- ***3. Informed consent*:** Engineering experimentation is viewed as **Societal Experiment** since the subject and the beneficiary are human beings. In this respect, it is similar to medical experimentation on human beings.

- In the case of medical practice, the persons who undergo the test have moral and legal rights to know about the fact which is based on "informed consent" before take part in the experiment. Engineering must also recognize these rights.

- Informed consent has two basic elements:

  - *Knowledge*: The persons who are put under the experiment has to be given all the needed information to make an appropriate decision to participate.

  - *Voluntariness*: they must enter into the experiment without any force, fraud and deception. Respect for rights of minorities to dissent and compensation for harmful effect are assumed here.

Engineering Projects VS. Standard Experiments
(*Contrasts*) *3. Informed consent*:

- For a valid consent, the following conditions are to be fulfilled:
  - Consent must be voluntary
  - All relevant information shall be presented/stated in a clearly understandable form
  - Consenter shall be capable of processing the information and make rational decisions.
  - The subject's consent may be offered in proxy by a group that represents many subjects of like-interests
- Informed consent when bringing an engineering product to market, implies letting the customer know the following:

  (a) the knowledge about the product,

  (b) risks and benefits of using the product and

  (c) all relevant information on the product, such as how to use and how not to use (do's and don'ts). The relevant factual information implies, that the engineers are obliged to obtain and assess all the available information related to the fulfillment of one's moral obligations (i.e., wrong or immoral use of a product one designs), including the intended and unintended impacts of the product, on the society.

Engineering Projects VS. Standard Experiments
(*Contrasts*) *3. Informed consent*:

- Still there exists a possibility of a large gap of understanding between the experimenter and the subjects (public). Sometimes, the managements have not been willing to disseminate the full information about the project or product beyond the legal requirements, because of the fear of potential competitions and likely exposure to potential litigation.

Engineering Projects VS. Standard Experiments (*Contrasts*)

- ***4. Knowledge gained*:** Not much of new knowledge is developed in engineering experiments as in the case of scientific experiments in the laboratory.
- Suppose the outcomes of the experiment is best, it tells us nothing new. Mean while, the unexpected outcomes put us search for new knowledge.
- Engineering experiments at the most help us to (*a*) verify the adequacy of the design, (*b*) to check the stability of the design parameters, and (*c*) prepare for the unexpected outcomes, in the actual field environments.
- From the models tested in the laboratory to the pilot plant tested in the field, there are differences in performance as well as other outcomes.

ENGINEERS AS RESPONSIBLE EXPERIMENTERS

- In the engineering project, the engineers are the main technical enablers(or) facilitators.
- Their responsibility is shared with management, public, and others.
- The engineers have so many responsibilities for serving the society.

Social Responsibilities of engineers in experimentation

- ***1. Conscientiousness:*** *A* primary duty is to protect the safety of human beings and **respect their right of consent**. [A conscientious commitment to live by **moral values**].
- ***2. Moral Autonomy:*** *Unrestricted* free **personal involvement** in all the steps of a project.
- ***3. Relevant information:*** A **constant awareness** of the experimental nature of any project, **imaginative forecasting** of its possible side effects and a reasonable effort to monitor them. [comprehensive perspective or relative information].
- **4. Accountability:** Being **accountable** for the results of

CONSCIENTIOUSNESS
(sense of awareness)

- Conscientiousness implies **consciousness** (sense of awareness). **Conscientiousness** implies a **desire** to do a **task well**. **Conscientious** people are **efficient and organized** as opposed to easy-going and disorderly.
- As holding the responsible profession with maintaining full range of moral ethics and values which are relevant to the situation.
- Willingness to develop the skill and expend the effort needed to reach the best balance possible among various considerations.
- In order to understand the given situation, its implications, know-how, person who is involved or affected, Engineers should have **open eyes, open ears and open mind**.
- Example: [**Should not involve in**…]The small negative duties such as altering data by fraud, violating patent right and breaking confidentiality.

MORAL AUTONOMY

- This refers to the **personal involvement** in one's activities. People are morally autonomous only when their moral conduct and principles of actions are their own i.e., **genuine** in one's commitment to moral values.
- **Moral beliefs and attitudes** must be integrated into an individual's personality which leads to a committed action.

Relevant information

- Without relevant factual information, conscientious is not possible.
- Engineers have to show the commitment to obtain and properly gauge all the information related to meeting one's moral obligations.
- Moral concern involves a commitment (dedication) to obtain and assess all available relevant information.
- Another dimension to factual information is the **consequences** of what one does.

Accountability (Answerability)

- Means being responsible, liable, answerable or obligated.
- An engineer is always **answerable** for what he had undertaken. He must observe care and caution at every stage of his experiment, monitor it by his best capacity and skills and ultimately produce the outcome in the expected manner. **If there be failures** or errors, he must **accept** them with grace.
- The people those who feel their responsibility, always accept moral responsibilities for their actions. It is known as **accountable**.
- In short, ‘accountable’ means being **liable and hold responsible** for faults.
- In general and to be proper, it means the general tendency of being willing to consider one’s actions to moral examinations and be **open and respond** to the assessment of others.